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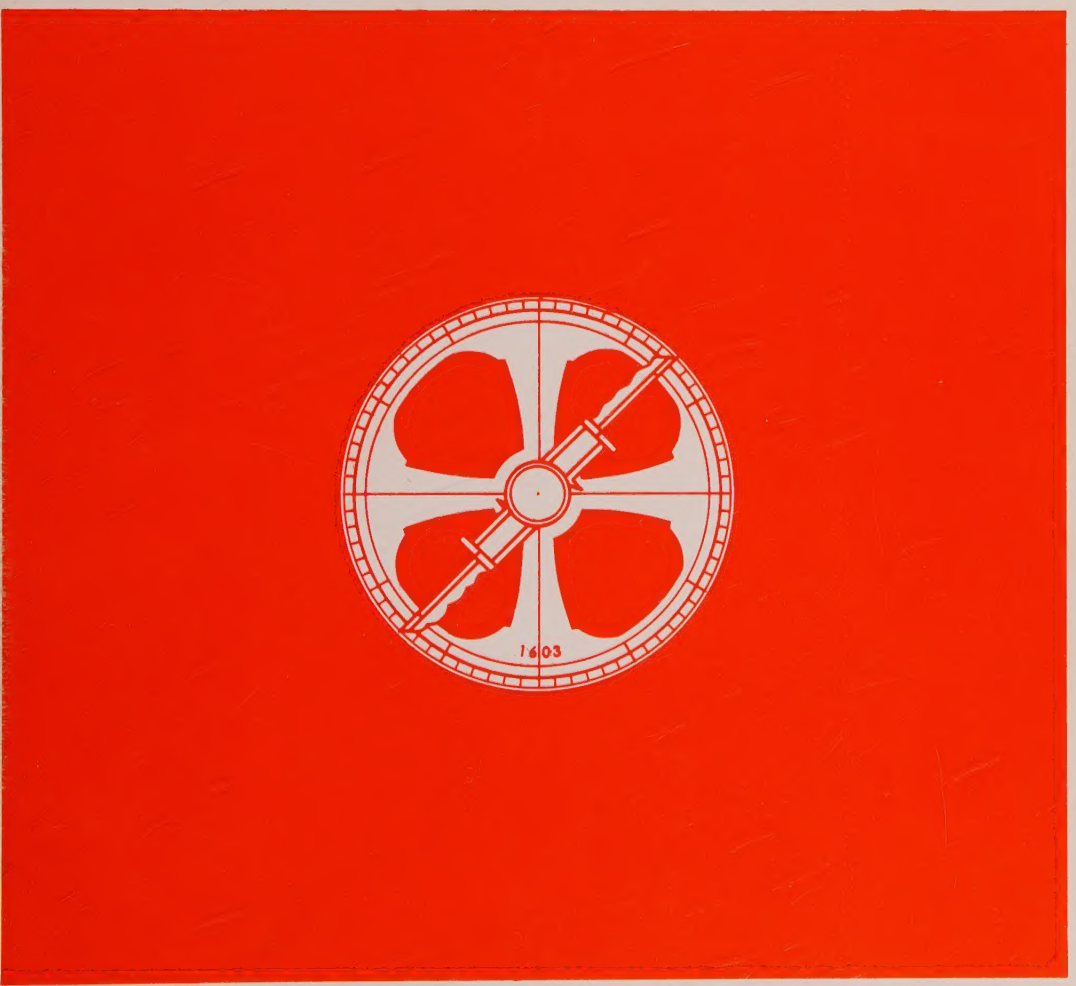

GEOGRAPHICAL BRANCH
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Ottawa, Canada

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GEOGRAPHICAL BULLETIN

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Address all correspondence to the Director, Geographical Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

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PREFACE

The *Geographical Bulletin* was first published in 1951 when the Branch was barely four years old. In the preface to Number One Dr. J. Wreford Watson, then director, stated that the work of the Branch would "be published, from time to time, in various memoirs . . . . (and) . . . . in the form of bulletins". Over the intervening thirteen years 22 issues have been published, initially on an unscheduled basis and, since 1962, twice yearly in May and November. The content has ranged widely across the breadth of our discipline, although later years have seen an emphasis on physical geography, a reflection of the decision made in 1961 to program field research in that specialization. The continued development of this endeavour, internal reorganization over the past year towards similar programming in economic geography and a recent growth in staff, have created the need for an extension of the Branch's publishing facilities. Hence the decision to produce the *Geographical Bulletin* as a quarterly and to increase its flexibility by the introduction of a new format and the adoption of a broadly-based editorial policy.

Both quantity and quality of content have changed, reflecting the growth of the organization. One thousand copies of Number One were printed and sold at 50 cents a copy, although several hundred are still on hand; numbers 19 and 20 were almost out of print within four months of release, despite a sale price of $3.75. Fifteen hundred copies are being produced for all future issues at a fixed price of $3.50; the four issues for each year will constitute one volume and the volume numbering system is explained as a footnote to this preface.

While most of the published material will be produced by the permanent staff, or by university faculty members who work for the Branch on a temporary basis, articles of outstanding merit on the geography of Canada and related topics produced by independent scientists will be welcomed. Detailed instructions to contributors will be produced in the near future; in the meantime the content and editorial style of the current issue should serve as a guide. The Concise Oxford Dictionary, Fowler's Modern English Usage and Le Dictionnaire Larousse should be used as standard references along with the basic Canadian Government Style Manual. Articles will be published in French or in English, depending on the wishes of the author, with abstracts in each language.

The Branch plans to publish papers of a descriptive, interpretative or controversial nature ranging in length from a short note to 50 or 60 pages of print. Critical reviews of papers either in the form of "letters to the editor" or as review articles are solicited. From time to time notes on the development of the Branch, or on the development of the geographical profession in Canada will be included.

In conclusion there is one aspect of the history of the geographical profession in Canada that inspired the new cover design and the newly adopted Branch crest. In one sense geography is a very new discipline in Canada: Griffith Taylor founded the first Department of Geography at the University of Toronto in 1935, but not until the post-war years, and especially over the past ten years, did it grow to its present stature. In another sense geography and geographers can be traced back to the very founding of our nation. In 1603 Samuel de Champlain was appointed Geographer to the King of France, Henry IV; in 1613, on his historic journey of exploration and geographical discovery, which led him past the site of Ottawa to Lake Huron, he lost his astrolabe along the Ottawa River. Champlain's astrolabe has been adopted as our crest and the centre-piece of the cover design. It seems appropriate that the lost astrolabe serve in this capacity, thus bringing together the Geographical Branch and Canada's first government geographer; the Branch was founded in 1947 and, as with the rediscovery of the astrolabe, so the government of Canada has rediscovered the usefulness, within its ranks, of the geographical profession.

J. D. Ives,
Director, Geographical Branch.

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PRÉFACE

Le *Geographical Bulletin* a été publié pour la première fois en 1951 alors que la Direction comptait à peine quatre années d'existence. Dans la préface du premier numéro, M. J. Wreford Watson, le directeur, déclarait que les travaux de la Direction «seraient publiés de temps à autre sous forme de mémoires . . . . (et) . . . . de bulletins». Au cours des treize années qui ont suivi, 22 numéros ont paru, d'abord irrégulièrement, et depuis 1962, deux fois par année, en mai et en novembre. Les textes ont traité de tout ce qui touche à notre discipline quoique, ces dernières années, ils aient porté surtout sur la géographie physique, à la suite de la décision prise en 1961 de faire des recherches sur le terrain dans ce domaine. Les progrès continus de ces travaux, la réorganisation interne entreprise l'an dernier en vue de mettre sur pied des recherches semblables en géographie économique et une augmentation récente de personnel ont créé pour la Direction le besoin de donner plus d'ampleur à ses services de publication. D'où la décision de faire du *Geographical Bulletin* une publication trimestrielle et d'améliorer sa souplesse en lui donnant un nouveau format et en adoptant une politique très large dans le choix des textes.

La quantité et la qualité des textes ont changé, reflétant la croissance de l'organisme. On avait tiré le premier numéro à mille exemplaires, vendus à 50 cents l'unité, et il nous en reste encore plusieurs centaines. Quatre mois après leur parution, les numéros 19 et 20 étaient presque épuisés, en dépit du fait qu'ils se vendaient $3.75 l'exemplaire. Nous publierons à l'avenir à 1,500 exemplaires au prix fixe de $3.50. Les quatre numéros d'une année constitueront un volume et le système de numérotation des volumes est expliqué en note à la fin de cette préface.

La majorité des textes publiés seront rédigés par le personnel permanent ou des universitaires qui travailleront à la Direction de façon temporaire, et nous accueillerons avec plaisir les articles de grand mérite sur la géographie du Canada et les sujets qui s'y rattachent écrits par des spécialistes. Nous distribuerons prochainement des directives précises aux collaborateurs. Entre-temps, la matière du présent numéro et le style des articles doivent servir de guide. Le *Concise Oxford Dictionary*, le *Fowler's Modern English Usage* et le *Dictionnaire Larousse* serviront d'ouvrages de référence réguliers de même que le *Canadian Government Style Manual*. Nous publierons les articles en anglais ou en français selon le désir de l'auteur avec des résumés dans les deux langues.

La Direction entend publier des études de nature descriptive, interprétative ou controversée dont l'importance peut varier d'une simple note à un article de 50 à 60 pages imprimées. Nous vous invitons à présenter sous forme de lettres ouvertes ou de comptes rendus vos commentaires sur les études. De temps à autre, on insérera des notes sur l'évolution de la Direction ou de la profession de géographe au pays.

Pour conclure, disons qu'il y a un aspect de l'histoire de la profession de géographe au Canada qui a inspiré la nouvelle présentation de la couverture et le nouvel écusson de la Direction. Dans un certain sens, la géographie est une discipline très jeune au pays. M. Griffith Taylor a fondé le premier département de géographie à l'université de Toronto en 1935, mais ce n'est qu'après la guerre, et, en fait, en ces dernières dix années, que cette science a commencé à prendre de l'importance pour atteindre sa stature actuelle. Par ailleurs, la géographie et les géographes étaient présents à la naissance de notre pays. En 1603, Samuel de Champlain était nommé géographe de Henri IV, roi de France. En 1613, lors de son voyage historique d'exploration et de découvertes qui l'a conduit jusqu'au lac Huron en passant par l'emplacement actuel d'Ottawa, il perdit son astrolabe sur les bords de la rivière Outaouais. Nous avons retenu l'astrolabe de Champlain comme écusson et pièce centrale de notre page-couverture. Il semble approprié d'utiliser l'astrolabe pour faire le lien entre la Direction de la géographie et le premier géographe officiel du pays. La Direction a été fondée en 1947 et, avec la redécouverte de l'astrolabe, l'État a aussi redécouvert l'utilité de la profession de géographe.

le directeur de la géographie,
J. D. IVES.

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Volume 5—Nos. 17 to 20, 1962–63
Volume 6—Nos. 21 and 22, 1964
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GLACIER FLOW AND ANALOGUE SIMULATION

J. Ross Mackay

ABSTRACT

An analogue field plotter was used to simulate the macroscopic pattern of glacier flow for large ice sheets of the Wisconsin glaciation. The results were promising enough to suggest that refinements in the technique may make it possible to simulate the accumulation, expansion, coalescence and wastage of ice sheets under varied topographic and climatic conditions.

RÉSUMÉ

On a utilisé un restituteur analogique pour simuler le mode macroscopique de déplacement des glaciers qui prenaient naissance dans le vaste champ de glace à l'époque du Wisconsin. Les résultats furent tellement encourageants qu'on décida, après les retouches nécessaires à la technique opératoire, de simuler les phénomènes d'accumulation, d'expansion, de coalescence et de déperdition des nappes de glace dans diverses conditions topographiques et climatiques.

INTRODUCTION

A wide-ranging variety of simulation methods are used in theoretical and applied analyses of innumerable problems involving both physical and "human" systems. Some of the simulations are carried out on high-speed digital computers with discrete items, others on analogue computers with quantities that vary without loss of continuity. This paper is a report on the results of preliminary tests made with an analog field plotter in an attempt to simulate the late-glacial flow of the Wisconsin ice sheet in North America.

Analogue field plotters may be obtained commercially or made without difficulty.[1] Briefly, a conductive solid, which in the experiments herein described was a sheet of special conducting (Teledeltos) paper, is prepared in the same geometrical shape as the field under study. The boundary conditions of the field are electrically simulated. When a conducting paper is used, the electrodes are painted on it at their precise positions with a special silver conducting paint. The voltage distribution within the conducting sheet is sensed with a probe joined to a galvanometer, and equipotential lines are then plotted. The lines of current flow are drawn freehand to cross the equipotential lines at right angles. The end result is a flow net whose lines are like the isogonic lines of the earth's magnetic field on a map. The plot is fundamentally a solution of the Laplace equation[2] in two dimensions. As the field patterns of many other physical systems, such as those of fluids, also depend upon a solution of this equation, the broad applicability of the technique is self-evident. The great attraction of the method is that graphic solutions can be derived

[1]The Servomex Field Plotter FP 92 and a home-made plotter were used in the experiments here discussed. Some of the more helpful of the many publications on analogue simulation are as follows:

Karplus, W. J.
1958 : Analog simulation. McGraw-Hill, New York, 434 p.

Murray, F. J.
1961 : *Math. Machines* 11. Columbia Univ. Press, New York, 365 p.

Olsen, G. H.
1962 : Field plotting. *Wireless World*, 68, 58-64.

[2]The Laplace equation in two dimensions is

$$\frac{\delta^2 V}{\delta x^2} + \frac{\delta^2 V}{\delta y^2} = 0$$

where V is the potential function and x and y are the conventional rectangular co-ordinates. This equation must be satisfied at every point in the field within the specified boundary conditions.

for physical systems with boundary conditions whose mathematical solutions would be too difficult or impractical. The analogue field plotter, in particular, is ideal for the study of fluid dynamics in two dimensions and is commonly used to plot flow nets for ground water investigation.

GLACIER FLOW

It is common knowledge that the motion of an ice sheet is by no means fully understood. Numerous variables are introduced by the rates of glacier nourishment, the numbers, shapes and heights of accumulation centres, temperature influences on vertical velocity profiles, perturbations caused by irregularities of the bed topography, and other factors. Thus, to test the use of the analogue field plotter in the simulation of glacier flow, certain simplifying assumptions must be made.

In the macroscopic view, for example, flow tends to radiate from a centre (ice divide) where the bed is reasonably horizontal. Centres, in fact, are usually determined by identifying areas from which flow lines diverge. Although these lines may curve between source and terminus, they are generally at right angles to both the source divide and the ice front. There is clearly a similarity between the macroscopic flow pattern of an ice sheet and that of fluid flow. The analogue field plotter may therefore be of use in a simulation of glacial flow. It can, of course, be argued that the analogue approach is circular—that, because the glacier-flow pattern resembles the fluid-flow, the pattern resulting from an analogue method based upon the simulation of fluid flow should resemble that of glacier flow and that the similarity consequently does not prove the case. In connection, however, with large complex ice sheets such as North America's Wisconsin, with its widely distributed centres and very long terminus, which ended on both land and water, any agreement between an analogue flow pattern and a glacial map should be viewed with at least as much interest as skepticism. If the general flow pattern can be approximated, the technique can undoubtedly be refined and thus reconciled with some of the details of current theories of movement in marginal zones, such as variations introduced by bottom topography and shifts in centres (ice divides).

A further simplification, made to facilitate the preliminary testing of the technique, is based upon a conditional assumption that all the glacial-flow features and postulated ice divides shown on the source maps (Glacial Map of Canada, 1958; Flint, 1957; Glacial Map of North America, 1945; Craig and Fyles, 1960; Mackay, 1958 and 1963) were formed contemporaneously. This is admittedly a gross over-simplification, since flow features over wide areas were probably formed within the marginal zones of the ice sheet, each of which was successively closer to the postulated centres of dispersal and so was formed during a progressively later phase of the deglaciation. Throughout this period, furthermore, the dispersal centres themselves probably moved significantly.

Finally, recent work has shown that the glacial conditions suggested for the Baffin-Ellesmere complex require extensive modification and addition (Ives and Andrews, 1963).

It is not the purpose of this paper, therefore, to attempt a projection of actual former conditions of ice flow, but rather to test the method against compiled data widely available to the scientific community.

Figure 1 shows an analogue simulation of late-glacial flow based upon inferred centres and termini of the last Wisconsin. As a parallel shift of the boundary—50 miles outward or inward, for example—would exert little effect on the flow pattern at the present scale, the limits of the analogue have been smoothed and generalized. The boundary for the mainland area has been generalized from Flint (1957), the Glacial Map of Canada (1958) and the Glacial Map of North America (1945). The boundary in the District of Mackenzie and Yukon Territory is smoothed from that given in the Glacial Map of Canada (1958). The boundary in the Arctic Islands is generalized from several sources, principally the Glacial Map of Canada (1958), Craig and Fyles (1960), and Mackay (1958 and 1963). The ice divides in mainland Canada are generalized from the Glacial Map of Canada (1958), and the ice divide of the Ellesmere-Baffin Island complex has been determined from a combination of sources.

Two types of termini are shown on the map, namely, wastage and nonwastage. The outer terminus of the ice, which begins at the Yukon coast and runs clockwise to southern Alaska (Figure 1, dashed line), was painted on conducting (Teledeltos) paper with silver paint to form one electrode. This ice terminus was assumed to have been a wastage boundary, whether it lay on land or in the sea; consequently, the flow lines meet the ice

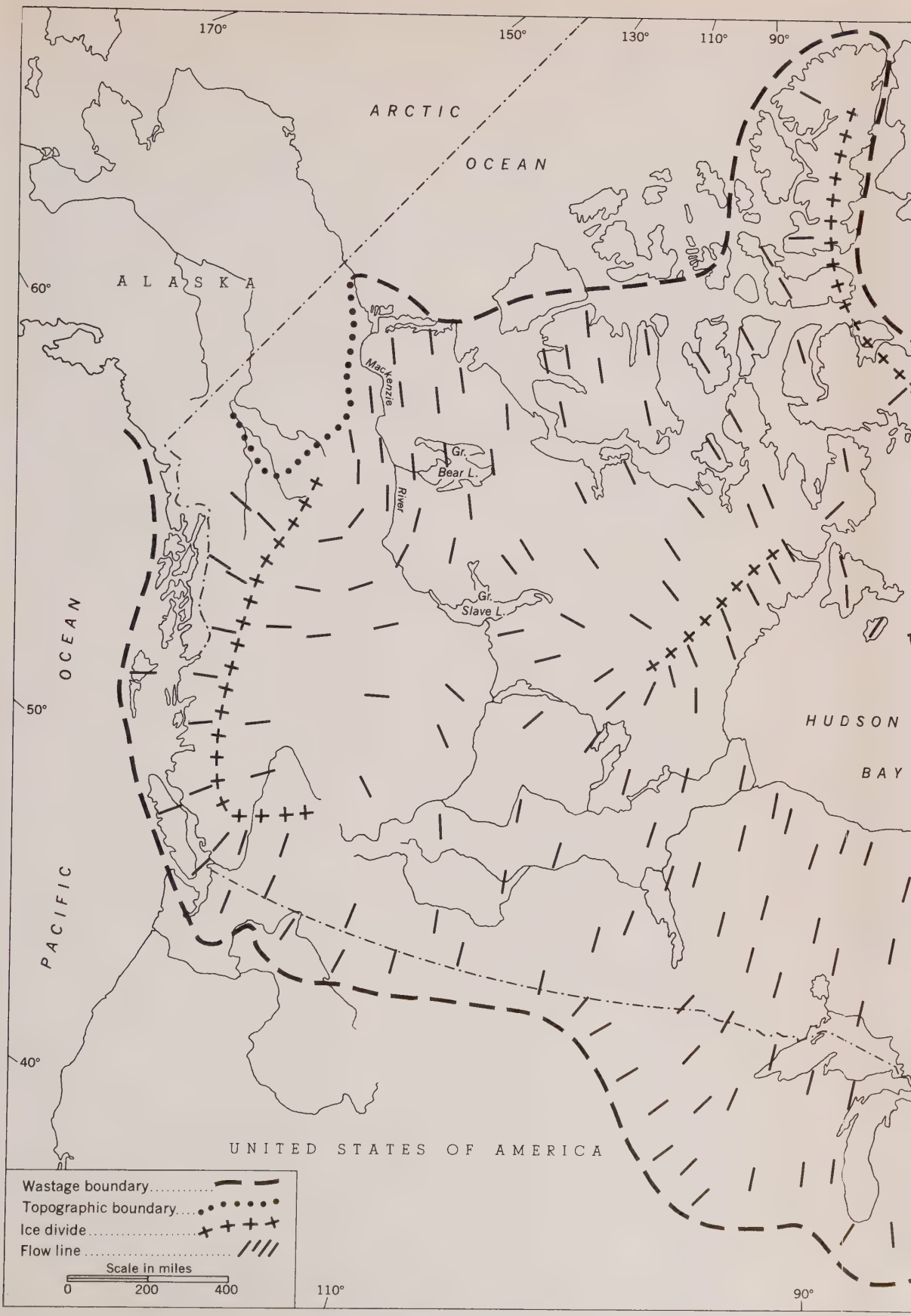
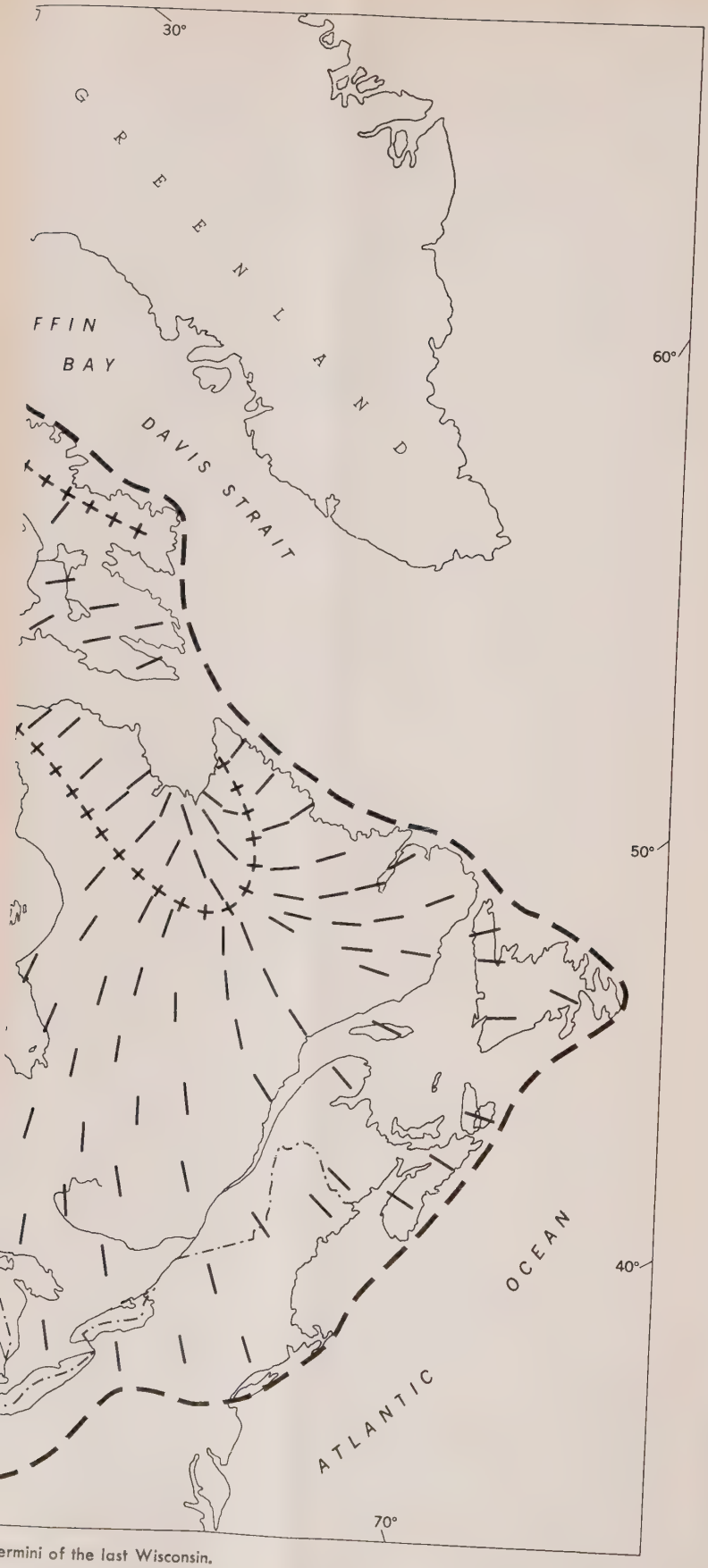


FIGURE 1. Analogue simulation of late-glacial flow based upon inferred centre



ermini of the last Wisconsin.

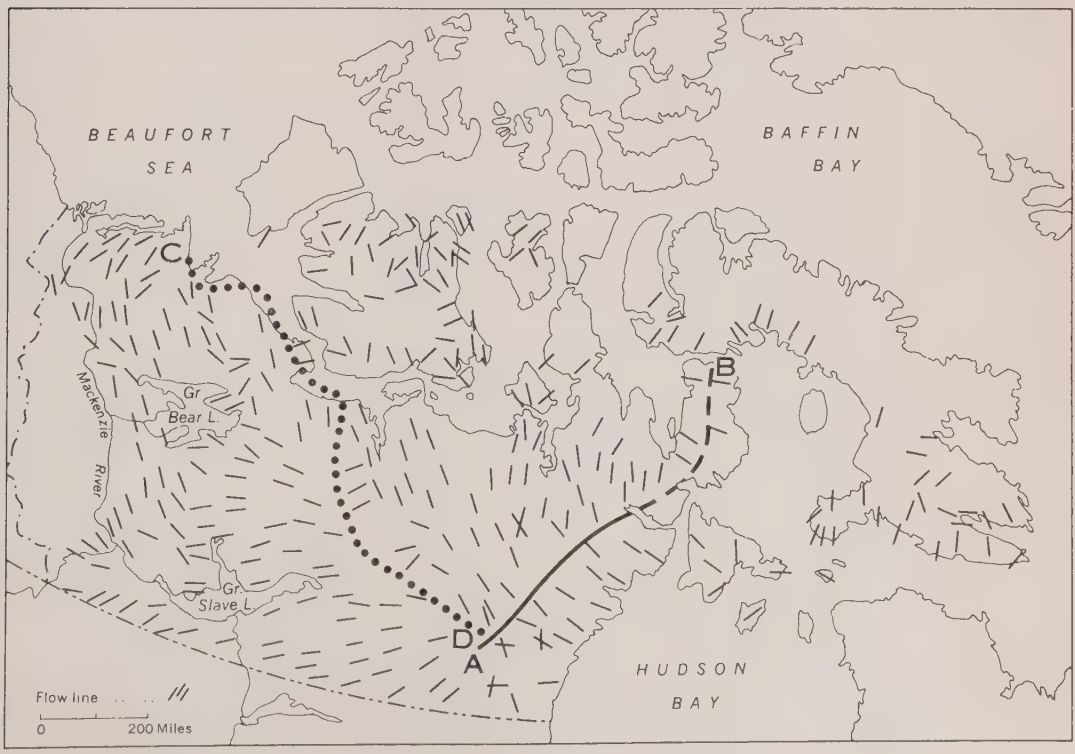
front at right angles, irrespective of curvatures in the boundary. On the other hand, the terminus in Yukon Territory (Figure 1, dotted line) was assumed to have been primarily a topographic-friction boundary along which the ice moved as an alpine glacier moves along its valley sides. For example, ice impinging against the Richardson Mountains was deflected northward. To allow the equipotential lines to sweep freely along the ice margin, this Yukon boundary was left unpainted (was not made an electrode). The other electrode (input source) represented the four ice centres, which were marked in with silver paint and then joined with a wire so as to share a common voltage. Equipotential lines were then plotted on the sheet and the flow lines sketched in freehand normal to the equipotential lines to form a flow net.

The resemblance of the flow pattern in Figure 1 to that of a glacial map of North America is evident from a casual glance. The principal areas of divergence occur in geometric positions where a slight shift in one factor, such as in either the wastage or source electrode, effects a large shift in flow lines. Such critical areas are near Lake Athabasca, the Melville Peninsula and Victoria Island and in several other locations. A comparison of the appropriate part of Figure 1 with the details of Figure 2, which has been only slightly generalized from a glacial map by Craig and Fyles (1960, Figure 3), will show the similarities and differences.

Simulations of part of the last Wisconsin ice sheet in the area from Great Bear Lake to the Mackenzie Delta region are illustrated in Figures 3 and 4. Figure 5 shows the fluting from the Glacial Map of Canada (1958) from the same area. Figures 3 and 4 differ in the electrodes that represent their source and wastage areas. To facilitate comparison, flow lines have been drawn in Figures 3 and 4 only where flow lines are present in Figure 5.

In Figure 4 a wasting terminus is shown from the Yukon coast to beyond Cape Bathurst. The slight dip in the terminus east of Herschel Island represents inferred calving along the corresponding part of the submarine valley. The boundary is placed north of the Mackenzie Delta and its off-

FIGURE 2. General directions of glacial flow in Northwest Territories. Craig and Fyles, GSC Paper 60-10.



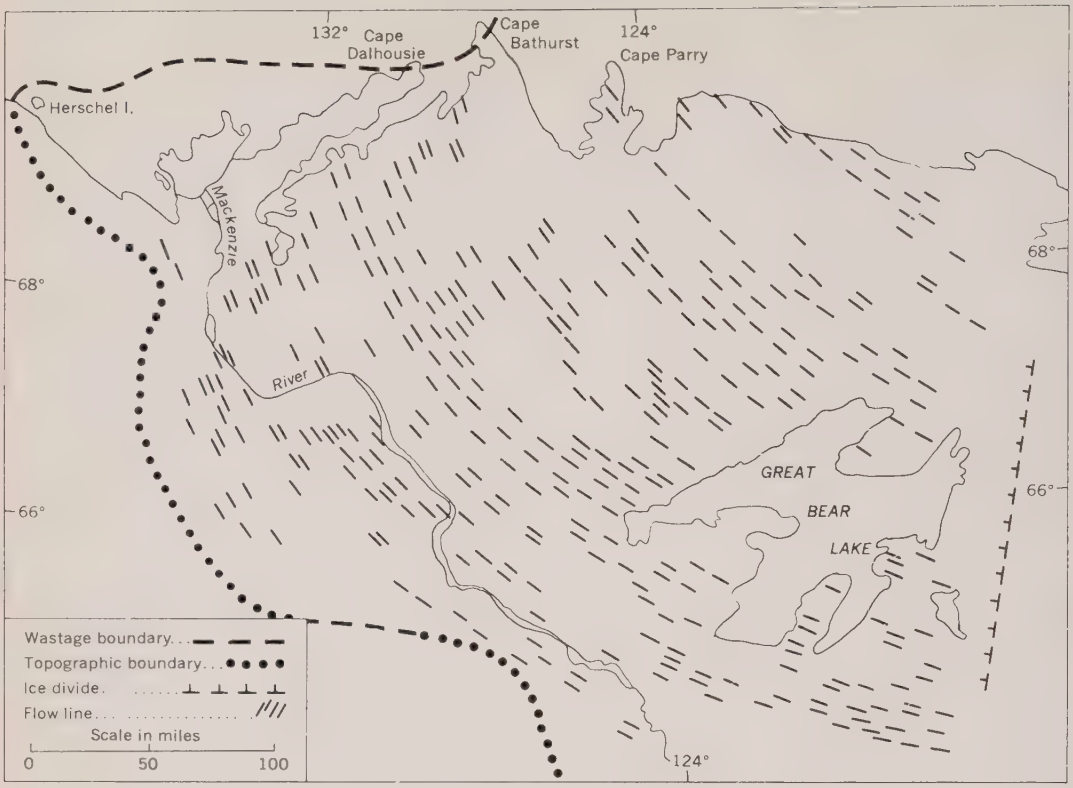


FIGURE 3. Simulation of the last Wisconsin ice sheet, Mackenzie Delta area.

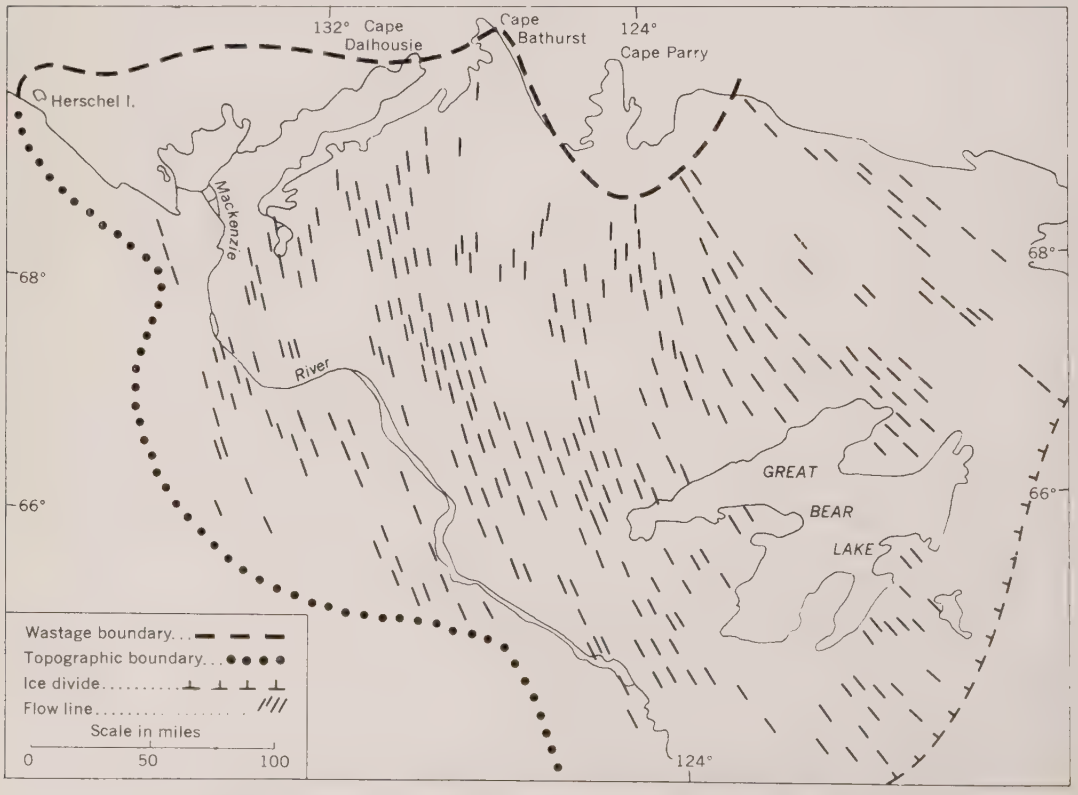


FIGURE 4. Simulation of the last Wisconsin ice sheet Great Bear Lake area.

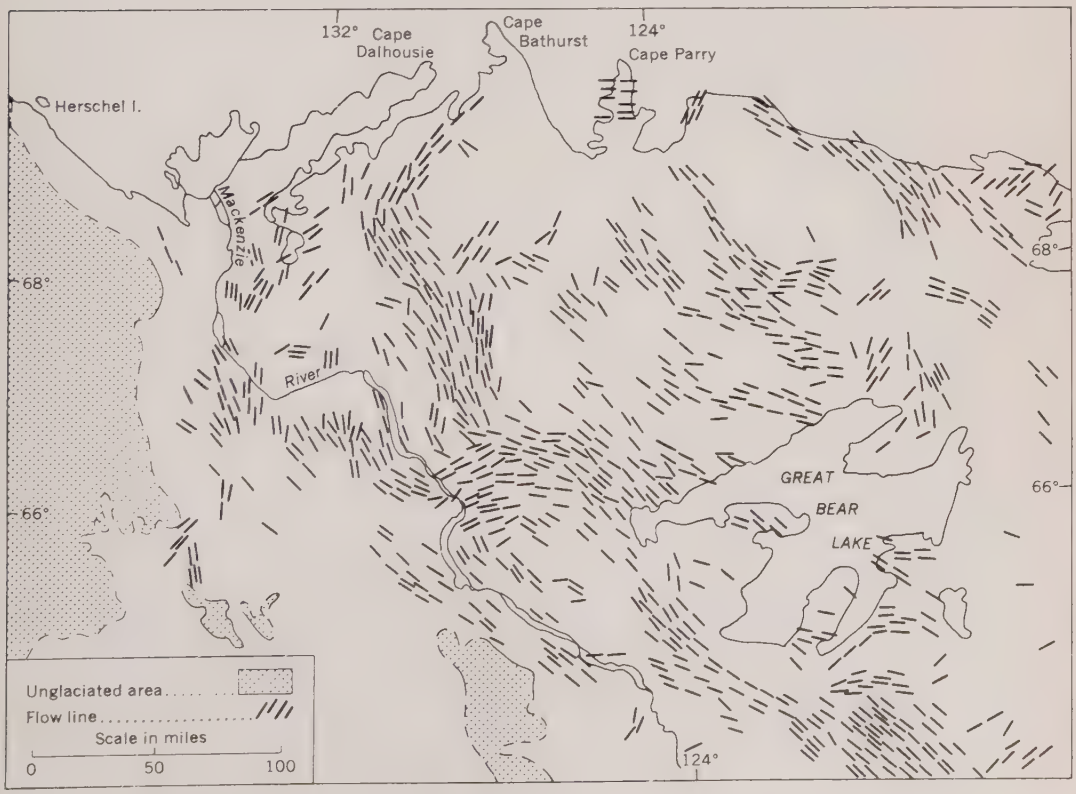
shore islands because all are believed to have been glaciated. It is placed slightly south of Cape Dalhousie and Cape Bathurst because both may have been unglaciated. A 100-mile northward shift of the boundary, however, would not greatly alter the flow pattern. A second wasting terminus, joined by wire to the first, was painted west of Great Bear Lake between two unglaciated areas, on the assumption that ice was lost through a southwestward ice movement. The source electrode was drawn east of Great Bear Lake along a line normal to the fluting of the Glacial Map of Canada (1958). In Figure 3, the boundary of the Amundsen Gulf Lobe (Mackay, 1958; Craig and Fyles, 1960) is drawn in, and the source area slightly lengthened and shifted from the position it occupies in Figure 4. A comparison of Figures 3 and 4 shows that in the latter, in the area north and northwest of Great Bear Lake, the fluting has been rotated clockwise. Figures 3 and 4 differ from Figure 5 in the complexity of the flow pattern between the northwest arm of Great Bear Lake and the Mackenzie River.

Simulations of the flow pattern of the Scandinavian Ice Sheet gave comparable results. In the Baltic-Denmark area, for example, a shift in the ice divide from the mountain crest to an eastward position (Flint, 1957, pages 366-371) duplicated the observed shift in ice flow.

CONCLUSION

The preliminary investigations, which have been partially summarized here, suggest that the analogue field plotter may be of use to simulate the macroscopic pattern of glacier flow for large ice sheets. If this assumption is valid, refinements in the technique may make it possible to simulate the accumulation, expansion, coalescence and wastage of ice sheets under varied topographic and climatic conditions. These refinements may include the following: variations in the source-area voltage input in accordance with the heights of centres, areal instead of linear representation of the shapes of centres, and changes in the conductivity of the paper to reflect topographic ir-

FIGURE 5. Fluting from Glacial Map of Canada (1958).



regularities as they affect flow lines. Certain aspects of glacier flow might be investigated three-dimensionally in an electrolytic tank.

In both physical and human geography, the analogue field plotter has many other applications. Given ground temperatures, the physical geographer can use it, for example, to map isotherm surfaces in a permafrost area. With it, the cartographer can demonstrate conformal mapping. It can help the human geographer experiment in fields of study involving models of interactance, potential and migration.

MS submitted May, 1964

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HISTORICAL RECORDS OF FREEZE-UP AND BREAK-UP ON THE CHURCHILL AND HAYES RIVERS

D. K. MacKay and J. Ross Mackay

ABSTRACT

Long-term records of ice conditions on the Churchill River (from 1719) and the Hayes River (from 1714) were extracted from Hudson's Bay Company archives and subjected to statistical analysis by modern electronic computing techniques. It was found that on both rivers there is greater variability in freeze-up dates than in break-up and that, partly because of the character of discharge, break-up on the Churchill occurs an average of 27 days later. The discharge of the Churchill is stabilized by lakes more than that of the Hayes.

The covariability of break-up dates is greater than that of freeze-up, but neither river shows in its records a trend toward earlier freeze-up or later break-up. The time of harbour-closing at Churchill can be estimated with fair accuracy (with a standard error of 2.6 days) on the basis of temperature alone. This paper includes regression equations for estimating temperatures that predate the use of temperature-measuring instruments.

RÉSUMÉ

Les données consignées au cours d'une très longue période d'observations des conditions de la glace sur la rivière Churchill (depuis 1719) et la rivière Hayes (depuis 1714) sont extraites des archives de la compagnie de la baie d'Hudson et ont fait l'objet d'une analyse statistique effectuée à l'aide de calculatrices électroniques. On a constaté que, sur ces deux cours d'eau, les dates de gel varient beaucoup plus que celles du dégel et que, à cause du caractère de l'écoulement, la débâcle sur la Churchill a lieu 27 jours plus tard en moyenne. L'écoulement de la Churchill est retardé par les lacs plus que celui de la Hayes.

La covariabilité des dates du dégel est plus grande que celle du gel, mais rien dans les archives relatives aux deux rivières n'indique la moindre tendance à un gel plus hâtif ou à un dégel plus tardif. La seule température peut servir de fondement pour déterminer avec une précision raisonnable (à une différence de 2.6 jours près) la date de la fermeture du port à Churchill. La présente étude comprend des équations de régression pour le calcul des températures antérieures à l'emploi des instruments de mesure de cette température.

INTRODUCTION

The examination of climatic fluctuations and trends in parts of North America is hindered by a lack of long-term instrumental records. In areas where formal meteorological data are limited, recorded observations of natural events can be a valuable source of information about past climate. For example, ice formation and ice disintegration on rivers and lakes reflect the integrated effects of climatic elements. Thus, dates of freeze-up and break-up are fairly reliable indicators of variations in climate.

The study of climatic variation is of fundamental importance in the research program of the Geographical Branch. It persists because it is basic to the full understanding of geomorphic processes and the evolution of landforms. Glacial recession and advance, for example, are primarily functions of climatic change. This examination of historical ice records should therefore be of value to the Branch in its intensive glaciological research.

Two of the longest records of freeze-up and break-up in North America are those for the mouths of the Churchill and Hayes rivers (Figure 1). Observations of ice conditions on these rivers are recorded in journals kept by Hudson's Bay Company personnel at posts that were established in the latter half of the seventeenth century. Owing to the loss of these posts to the French during the struggle for possession of Hudson Bay, no records are available for the years prior to 1714, when the Hayes post, York Factory, was repossessed. Fort Churchill was

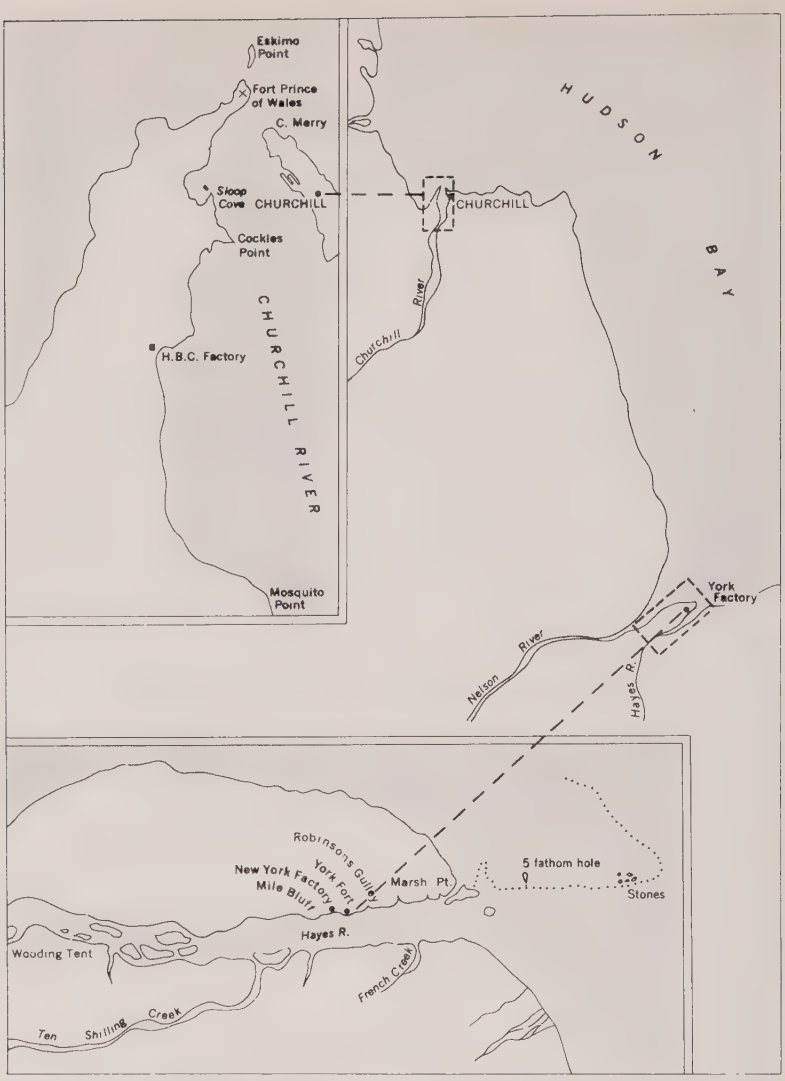

FIGURE 1.
Location of Churchill and Hayes river mouths.

rebuilt by James Knight in 1717, and the recording of ice conditions on the Churchill River began the following year.

Observation sites

Ice conditions on the Churchill River were observed both from the Hudson's Bay Company factory (1719-1739; 1783 to end of record), 5 miles upstream from the mouth, and from Fort Prince of Wales (1740-1782), at the mouth. On the Hayes River from 1714 to 1791 inclusive, ice conditions were observed from a site about 5 miles above the outlet (Marsh Point). In 1792, a new factory was built a short distance above the old. Ice observations made from this site are recorded in the York Factory journals from 1792 through the 1939 break-up season.

Nature and extent of the data

The omissions and overlap of data gathered from different sources are illustrated in Figure 2. The Hudson's Bay Company data for the Churchill River were supplemented by the addition of harbour-closing dates from the Department of Transport (CIR-3156 ICE-2) and from the National Harbours Board (P. D. Williams, personal communication). Data from the York Factory journals were supplemented with dates contained in the Geological Survey of Canada Report of Progress, 1879-1880 (Bell, 1881).

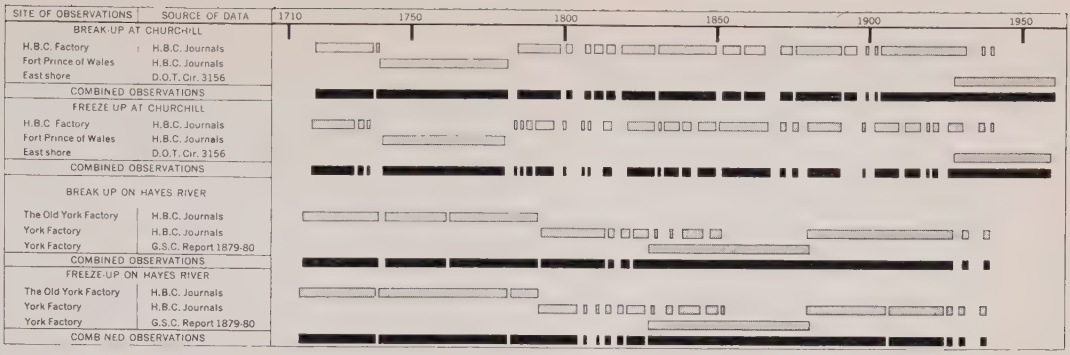

FIGURE 2. Break-up and freeze-up records for the Churchill and Hayes river mouths.

Dates of freeze-up and break-up extracted from the Fort Churchill and York Factory journals present some difficulties in interpretation. The recording of ice observations is subjective, especially so, no doubt, at the Hudson's Bay Company posts, where the criteria for ice conditions were not defined and the observers were frequently changed. Ice conditions were nevertheless important enough to be normally recorded with care. Another complicating factor is the use of place names that do not appear on present maps. Most of these were located with the help of the research staff at Hudson's Bay House, Winnipeg. A further problem, encountered while the records were being scanned, is that in some years only intermediary stages of freeze-up and break-up were reported. An attempt was made to reconcile these differing ice-condition dates so that the Fort Churchill and York Factory records could be compared.

Adjustment of the data

The entries in the post journals are such that the data must be adjusted if comparisons are to be made at specific locations. As an illustration, the 1717 break-up and freeze-up record for York Factory is as follows: May 11—river broke up 9 to 10 miles upstream; May 13—South Channel broken up; May 14—break-up at Factory; October 25—river frozen over in some places; October 28—river breaks up with gale; November 4—river frozen over 9 miles upstream; November 16-17—river frozen over this day.

FREEZE-UP

There are more references to freeze-up as "completely frozen," "river fast," "river frozen this day," etc., than to ice conditions at specific river locations. Dates of freeze-up at upriver locations were therefore adjusted to inferred dates of complete freeze-over. The adjustments were made as follows:

(1) Churchill River

Mosquito Point to "river fast"

Mean	20 days
Median	22 "
Adjustment used	20 "

Mosquito Point to H.B.C. factory (5 miles upriver from mouth)

Mean	12 days
Median	12 "
Adjustment from factory to mouth, 20 − 12 =	8 "

Difference between ice on tidal flats or beach and at "river fast"

Mean	24 days
Median	21 "
Adjustment used	24 "

Other adjustments

Sloop Cove to mouth	4 days
Launch to mouth	4 "
Whale's Point to mouth	1 day
House to mouth	8 days

Vague references to freeze-up (for example, "river nearly frozen") and to sites that could not be located (for example, "wooden hammocks") were adjusted within the limits imposed by the availability of other information for that particular year.

(2) Hayes River

It was generally found that freeze-up progresses downstream from the area of the factory to the mouth (Marsh Point) at the rate of 1 mile a day. The calculation is based on the average difference between freeze-up dates at the factory and at Marsh Point.

BREAK-UP

Break-up dates were adjusted as follows:

(1) Churchill River

Mosquito Point to mouth	
Mean	8.5 days
Median	8 "
Adjustment used	8 "
House to mouth	
Mean	5.5 days
Median	5 "
Adjustment used (for agreement with other adjustments)	6 "
Cockles Point to mouth	
Mean	4.3 days
Median	3 "
Adjustment used	4 "

Other adjustments made for locations between Mosquito Point and the mouth were interpolated from those previously indicated.

(2) Hayes River

Adjustments from upriver locations to the mouth were made in accordance with the assumed rate of progress of 1 mile a day.

Difference between new factory and mouth	
Mean	5 days
Median	5 "

The basis is the same as for the adjustment of freeze-up dates.

FREEZE-UP AND BREAK-UP ON CHURCHILL AND HAYES RIVERS

On both rivers, break-up has been recorded more regularly than freeze-up. The values on which comparable freeze-up means are based are therefore fewer. The pairs of dates used to compute the mean open season are further reduced in number because for years for which freeze-up dates have been recorded there is an occasional lack of recorded break-up observations. In examining Table 1, which gives means and standard deviations of paired series, it should be noted that the difference in days between the break-up and freeze-up means for Churchill varies by one day from the mean open season calculated from paired series. At York Factory, both methods of computing the mean open season result in the same number of days. These comparisons indicate that, in spite of considerable variation in sample size, the mean open season on these rivers is subject to little change. For both rivers, there is greater variation in the dates of freeze-up than in those of break-up.

Freeze-up is delayed at the mouths of both rivers by tidal action and the lower freezing temperature of sea water. This is substantiated by earlier freeze-over dates at Churchill and York Factory, each of which is about 5 miles upstream from the river mouth.

Differences in the configuration of the outlets may have a considerable effect on freeze-up dates. The Churchill River widens to lake-like proportions before emptying through a narrow opening into the sea. For about 8 miles above the entrance, extensive tidal flats are exposed at low water. The mouth of the Hayes is markedly different. Downstream from York Factory, the river opens gradually into Hudson Bay. Tidal flats do not extend as far upstream as the factory.

These physical differences suggest that changes in tidal stage would produce high current velocities in the Churchill outlet area and relatively lower velocities at the mouth of the Hayes. Some indication of the current strength at the entrance to Churchill Harbour is given by James Knight in his 1717 journal. "Wee Arriv'd this Day," he writes, "abt 2 a Clock of Off Churchill River Mouth but did not gett in Twill 5. it being Ebb & the tide Running very Strong wee was forcd to an Anchor of off ye Mouth of ye River" (Kenney, 1932). Another indication of the influence of tides and currents was the presence of open leads at the Churchill River mouth throughout some winters (Keith, 1959). It has also been estimated that the volume of tidewater flow in the Churchill estuary may be as much as 10 times the volume of river flow (Donovan, 1957).

Because of the configuration differences between the two river outlets, the formation of a solid ice cover probably takes three days longer, on the average, at the mouth of the Churchill than at the mouth of the Hayes. This is borne out by the adjustments that were required to standardize freeze-up dates on the two rivers. On the

Churchill the average difference in freeze-up time between the factory and the river mouth is eight days; on the Hayes it is five days. Both factories are about the same distance above the river outlets. It may thus be inferred that, under local climatic conditions, a solid ice cover would form six days earlier at the mouth of the Churchill than at the mouth of the Hayes.

Table 1

*Paired series: means and standard deviations of ice conditions at mouths of Churchill and Hayes rivers**

River	Freeze-up mean	Standard deviation (148 obs.)	Break-up mean	Standard deviation (174 obs.)	Open-season mean	Standard deviation (104 obs.)
Churchill	Nov. 15	12 days	June 16	8 days	153 days	15 days
Hayes	Nov. 18	11 days	May 20	9 days	182 days	15 days

*The values are rounded.

Owing to the nature of the break-up process, tide action has less effect on break-up than on freeze-up. As on other northward- and eastward-flowing rivers of central Canada (Mackay, 1961b; MacKay, 1962), break-up on the Churchill and the Hayes progresses downstream. This is indicated by the correlation (0.60) between break-up at Island Falls and the break-up that occurs downstream at Churchill at a later date. The journals also contain numerous references to the downstream progression of ice clearance in the lower sections of the Churchill and Hayes rivers.

Normally, break-up on a main northerly-flowing river channel is generated by moderating climatic conditions in the upstream areas, where melting temperatures cause a rapid increase in discharge and a weakening of the ice cover. Meanwhile, side channels form along the banks. Rupturing occurs at weak points, and ice floes move downstream and may jam at natural constrictions or sharp bends along a river's course. The pressure of impounded water behind an ice dam, combined with ice abrasion and melting, eventually result in the dam's disintegration and a surge downstream, these processes being frequently repeated. The Churchill and Hayes rivers generally follow this pattern.

Break-up occurs an average of 27 days earlier on the Hayes than on the Churchill, but the cause of the earlier break-up is not solely the more southerly location of the Hayes River basin. The most important factor is perhaps the character of the discharge.

Discharge on the Hayes is less subject to the stabilizing effect of lakes; it may reach its peak more quickly and exert greater pressure on the river's ice surface during the spring run-off. Ice disintegration is extremely rapid, and flooding in the lower stretches of the river is not uncommon. In the early days, the inhabitants of old York Factory were often unprepared for the floods that accompanied break-up. In 1715, James Knight reported that the garrison was forced "to leave the Factory & betake ourSelves to the woods and gett on Trees & Stages the Water Rising above nine foot upon the land & continued up for Six Days, was looking every minute when ye Factory would be tore to pieces. The Ice lay heap'd & crowded at least 20 foot higher yn the Factory ...." (as reported by Tyler, 1955).

The mean open season is approximately one month longer on the Hayes than on the Churchill. Extremes of both records show that the length of the open season has varied by as much as two months.

The covariability of break-up, freeze-up and open season on the two rivers is shown in Table 2. Two values are given for both freeze-up and break-up.

Table 2

Covariability of ice conditions at mouths of Churchill and Hayes rivers
("r" value)

Freeze-up	Break-up	Open season
0.49[1]	0.62[1]	0.33[1]
0.53[2]	0.73[2]	—

[1]These correlation coefficients include data from the Geological Survey of Canada Report of Progress, 1879-1880 (Bell, 1881), which cover the period from 1828 to 1879 inclusive.

[2]The omission of the record referred to in footnote 1 from the calculation of the correlation coefficients in the second line improves the measure of covariability. Thus the lower "r" values are probably more representative of true covariability. As the dates they represent are grouped closely about over-all freeze-up and break-up means with extreme values unreported, there seems little justification for not including them in the calculations.

Note 1: All the values shown are significant at the 1-per-cent level.

Note 2: The extreme adjusted values are omitted.

Trends in Churchill and Hayes freeze-up and break-up records

Freeze-up and break-up dates for both river mouths fluctuate markedly over the period of record. For a visual presentation of ice-condition trends, each series of dates was smoothed. This was accomplished by a weighting system in which the plotted value for any year is the sum of 38 per cent of that year's ice condition date (taken from a standard base), 25 per cent of the dates of the preceding and subsequent years, and 6 per cent of the dates two years removed from the year plotted. The weights assigned are approximately in the same ratio as the coefficients of a fourth-power binomial expansion (for example, 1, 4, 6, 4, 1). The smoothed or filtered series are illustrated in Figure 3.

In these records, a sequence of observations is occasionally broken by a single omission. For purposes of continuity, the ice condition date for that year is estimated by averaging the two preceding and the two following dates. If the record is broken by the omission of more than one date in a sequence, the smoothed series is terminated. It should be noted that, as in any five-year moving average, two dates at each end of a sequence cannot be represented by smoothed values.

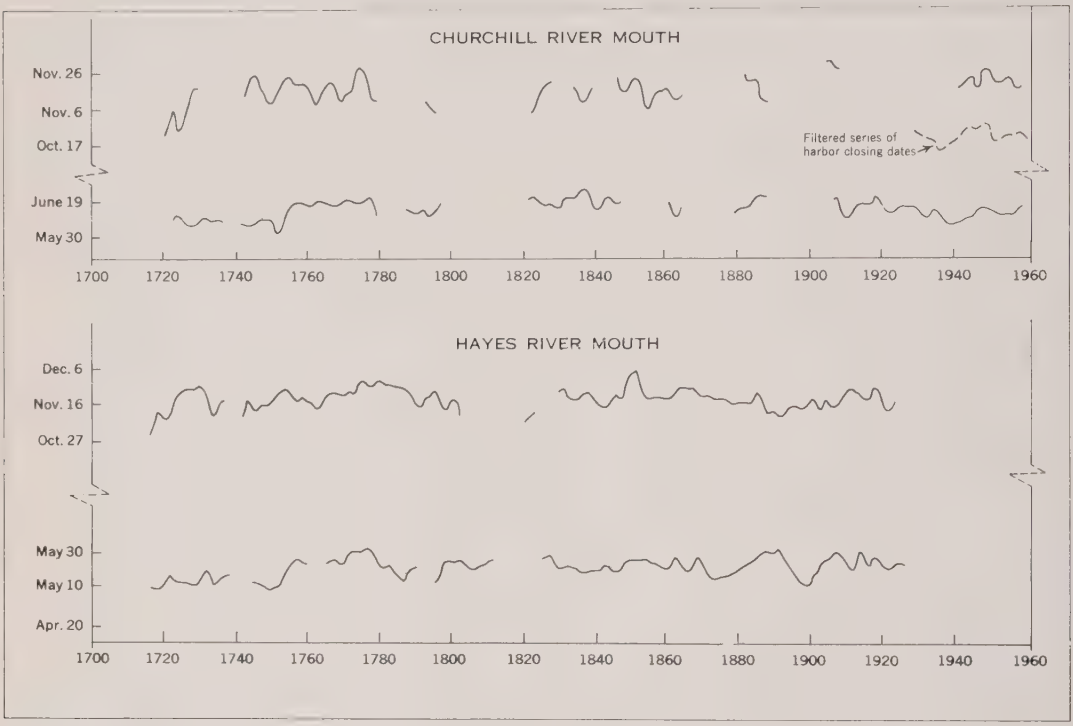

FIGURE 3. Filtered series of freeze-up and break-up dates for the Hayes and Churchill river mouths.

The records were also examined quantitatively by means of the turning-point test, which is used to find a random, stationary series. In its application, recourse was had to the original data. Smoothed data were not used because of the tendency of a moving average to induce a strong measure of autocorrelation in a series. (In certain cases, autocorrelation may be reduced but, whether it is or not, the results are biased.)

A turning-point is defined when

$$U_{t-1} < U_t > U_{t+1} \text{ or } U_{t-1} > U_t < U_{t+1}$$

where U_t is the ice-condition date for any given year. The expected number of turning points in a random, stationary series is $2/3(n-2)$ and the variance is $\frac{16n - 29}{90}$, where n is the number of observations in the series.

A visual examination of each of the series suggests that none of the four records have over-all trends. In each case, the turning-point test substantiates the visual interpretation. The results of this test are listed in Table 3.

One factor that may influence the results of the turning-point test is the incompleteness of the records. It seems clear, however, on the basis of the available data, that no over-all trends to earlier or later ice conditions exist.

Air-temperature and ice-condition dates

Ideally, ice conditions should be studied by means of a heat-budget analysis of the rivers, but lack of data makes this impossible. A heat-budget study requires information on water temperatures and meteorological data, which are currently unavailable. For this reason, ice conditions are related to air temperatures and not to the total heat budget.

Relations between spring-air temperatures at Churchill and dates of ice clearance from Churchill Harbour have been analyzed statistically by G. A. Mackay (1952). He reports that January, February and March temperatures are not significantly related to dates of ice clearance. He says, however, that April and May temperatures are significantly correlated with ice-clearance dates, the best correlation being obtained by using April plus double-weighted May temperatures. It thus seems that a method of estimating ice-clearance dates from air temperatures might be developed, particularly if upstream temperature data are included.

Table 3

Test for random stationary series: ice-condition records at mouths of Churchill and Hayes rivers

River ice condition	Number of turning points		Significance of difference at 5-per-cent level
	Expected	Actual	
Churchill freeze-up	119	119	not significant
Churchill break-up	140	136	" "
Hayes freeze-up	136	125	" "
Hayes break-up	139	136	" "

A number of methods for the estimation of freeze-up based on air temperatures have been developed, the most successful being one formulated by Rodhe (1952). Rodhe's method has been used to compute freeze-up at a number of Arctic coastal stations (Bilello, 1961), the computed dates generally falling within three days of the observed dates. It has also been used to estimate freeze-up at two locations on the Mackenzie River (Mackay, 1960, 1961a, 1961b and 1963). In the calculation of freeze-up for Fort Good Hope, on the main Mackenzie channel, and for Reindeer Station, on the East Channel of the Mackenzie Delta, air temperatures weighted to correspond to the estimated daily flow-travel distance of the river were substituted for local mean daily air temperatures. By this procedure, minimum standard errors of 2.45 days and 3.1°F were obtained for computed Fort Good Hope freeze-up dates. At Reindeer Station, standard errors were expressed in degrees. Use of optimum weighting factors and variation of the period examined showed standard errors to range between 1.78°F and 3.40°F.

At Churchill, local mean daily temperatures were used in conjunction with Rodhe's weighting system to estimate dates of harbour closing. Although upstream-air temperatures are undoubtedly a factor affecting ice formation in Churchill Harbour, local air temperatures were employed because temperature data at upstream locations were insufficient.

In Rodhe's method, an initial temperature value (in this case, the mean monthly temperature for August) occurring a considerable time before the closing date is selected as a base value. The difference between the base value and a succeeding temperature (here, the mean daily temperature for September 1) is weighted by a constant and the base is then adjusted by this weighted difference. This procedure is continued with successive daily mean temperatures including that of the date of closing. If, on the day of harbour closing, the weighted temperature value reaches 0°C, the constant is considered satisfactory. If this condition is not satisfied, a new constant is selected. The constant, $1\text{-}e^{-k}$, is varied by changing the value k^{-1}, its final value being determined by a process of trial and error (Bilello, 1961).

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The values of k^{-1} were calculated for 29 years of record with the aid of an electronic computer. The problem was programmed as follows:

$$XBT_1 = (XDT_1 - XBT_0) \quad (1 - e^{-k}) + XBT_0$$

$$XBT_2 = (XDT_2 - XBT_1) \quad (1 - e^{-k}) + XBT_1$$

$$XBT_n = (XDT_n - XBT_{n-1}) (1 - e^{-k}) + XBT_{n-1}$$

where XBT = base temperature that is successively adjusted, XDT = mean daily temperature and e^{-k} = exponential function. If XDT_n is the last daily temperature to be processed, XBT_n should reach 0°C. If it does not, the process is repeated with a new k^{-1} value until this condition is satisfied.

The mean value of k^{-1} (11.5) was used to determine estimated dates of harbour closing. The actual and estimated dates are listed in Table 4.

Table 4

Estimated and actual dates of harbour closing at Churchill
(k^{-1} value = 11.5)

Year	Actual harbour closing	Estimated harbour closing
1932	Oct. 14	Oct. 13
1934	" 27	" 25
1935	" 15	" 13
1936	" 10	" 9
1937	" 13	" 13
1938	" 26	" 27
1939	" 13*	" 11
1940	" 17	" 18
1941	" 24	" 23
1942	" 24	" 25
1943	Nov. 3	Nov. 3
1944	Oct. 28	Oct. 23
1946	" 12	" 12
1947	Nov. 8	Nov. 8
1948	" 9	" 8
1949	Oct. 22	Oct. 16
1950	" 20	" 12
1951	" 18	" 18
1952	" 16	" 13
1953	" 28	" 28
1954	" 29	" 28
1955	" 24	" 23
1956	" 23	" 21
1957	" 21	" 21
1958	Nov. 6	Nov. 6
1959	Oct. 17	Oct. 10
1960	" 18	" 18
1961	" 20	" 11
1962	" 25	" 24

*The 1939 harbour closing date is from the National Harbours Board. It is not as shown in Dept. Transp. Meteorol. Br. CIR-3156 ICE-2.

The fit of estimated dates to actual (recorded) dates is illustrated in Figure 4. The scattergram shows confidence limits of 95 per cent. The standard error of estimate is 2.6 days. The value of k^{-1} and the standard error of estimate are similar to those derived for two Mackenzie River stations, the agreement suggesting that the method might be suitable for many rivers.

The largest error (9 days) made in estimating the date of harbour closing occurred in 1961. "Ice began running on the river on October 12 and 13 and cleared again until October 20 when sufficient pack ice appeared to make the river unsafe for navigation" (Swanson, 1962). The date (October 12) on which fresh-water ice appeared on the river agrees closely with the estimated date (October 11). In 1959, a year in which the estimate (October 10) is seven days early, ice was observed floating down the river and out into the bay on October 9 (Keith, 1960). In these and other years in which the estimated and actual dates show considerable disagreement, wind and other factors may have disturbed the close relation that seems to exist between harbour closing and air temperatures.

The general criterion for the closing of the harbour at Churchill is the presence of enough river ice, much of which comes from upriver, to hamper the berthing and loading of vessels. Although such economic considerations as the tendency of insurance rates to increase as the season progresses may also be determinants, the closing date can be estimated with fair accuracy on the basis of the one variable, namely, air temperature.

Freeze-up and break-up at Churchill have also been studied by means of multiple-regression analyses, in which the dependent variables are the dates of freeze-up or break-up, and the independent variables are mean semi-monthly air temperatures preceding and following freeze-up or break-up. The computation period was 1932-62.

For freeze-up:

Y = date of freeze-up, days being counted from end of September

X_1 = mean temperature, Nov. 16–30

X_2 = " " " 1–15

X_3 = " " Oct. 16–31

X_4 = " " " 1–15

X_5 = " " Sept. 16–30

The elements of the total variation of freeze-up date, as defined by the addition of the successive independent variables, was tested by standard methods of variance analysis. Only X_3 and X_4 were significantly correlated with Y at the 95-per-

cent level of significance. The equations, given below, are significant at the 99-per-cent level:

Equation	Standard error	r
$Y = -\ 4.74 + 1.10X_3$	5.07	.75
$Y = -\ 21.16 + 0.85X_3 + 0.67X_4$	4.35	.82

For break-up:

Y = harbour opening, days being counted from end of April
X_1 = mean temperature, June 16–30
X_2 = " " " 1–15
X_3 = " " May 16–31
X_4 = " " " 1–15

The three equations, given below, are significant at the 99-per-cent level:

Equation	Standard error	r
$Y = 78.19 - 1.09X_3$	4.06	.59
$Y = 83.30 - 0.73X_3 - 0.67X_4$	3.09	.87
$Y = 96.36 - 0.61X_3 - 0.63X_4 - 0.46X_2$	2.69	.91

If the first simple regression equations are computed with dates of freeze-up and break-up as the independent variables and temperatures as the dependent variables, the equations for freeze-up and break-up are as follows:

$X_3 = 13.22 + 0.53Y$ (freeze-up)
$X_3 = 55.96 - 0.55Y$ (break-up)

The equations suggest that mean semi-monthly temperatures for October 16-31 (X_3) are about half a degree warmer or colder for each day's delay or advance in freeze-up date; a corresponding relation applies to mean temperatures for May 16-31 at break-up. If present conditions approximate past conditions, these equations may be used to estimate temperatures for periods preceding the keeping of instrumental temperature records.

Owing to a lack of meteorological data, relations between air temperatures and ice-condition dates for the mouth of the Hayes cannot be analyzed.

SUMMARY AND CONCLUSIONS

An examination of freeze-up and break-up records for the Churchill and the Hayes rivers leads to the following conclusions:

(1) For both rivers, the dates of freeze-up vary more than those of break-up.

(2) Break-up normally occurs significantly (an average of 27 days) later on the Churchill River, one cause being the character of the discharge. Lakes have a greater stabilizing

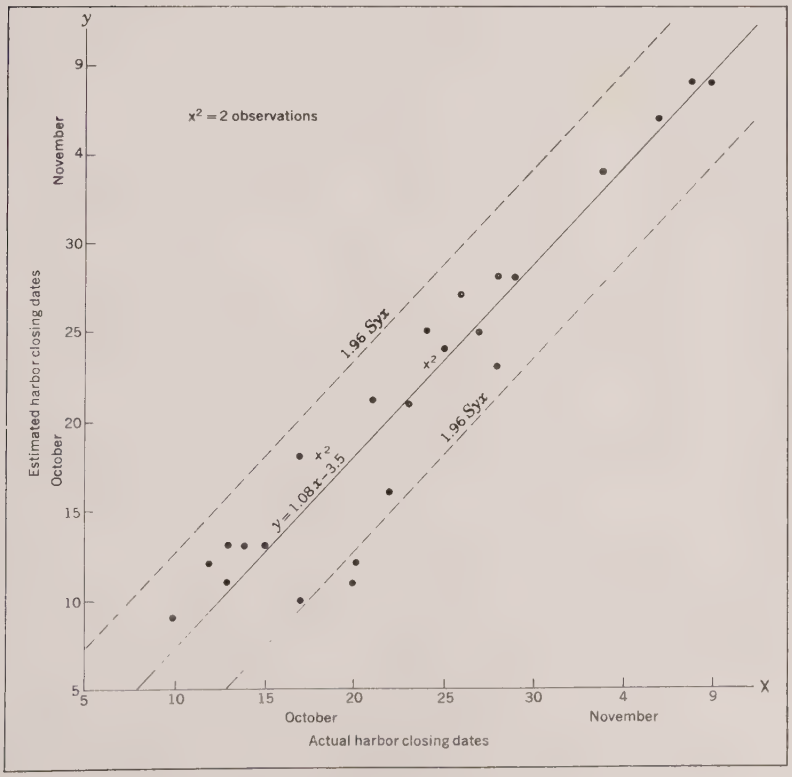

FIGURE 4.
Churchill Harbour closing 1932–1962.

effect on the discharge of the Churchill than on that of the Hayes.

(3) The covariability of break-up dates is greater than that of freeze-up.

(4) No trends toward earlier or later ice conditions are evident in the freeze-up and break-up records of the Churchill and Hayes rivers.

(5) Harbour-closing at Churchill can be estimated fairly accurately (with a standard error of 2.6 days) on the basis of one variable, namely, air temperature.

(6) Temperatures in effect before the recording of instrumental temperature data can be estimated for semi-monthly periods (May 16-31 and October 16-31) by means of regression equations given in the text.

MS submitted June, 1964

The estimation of harbour-opening dates at Churchill by a method similar to that used for harbour closing is at present under study.

ACKNOWLEDGMENTS

The writers are grateful to the Hudson's Bay Company for providing material from their archives in London, England, and granting permission to publish it. Miss B. J. Morrison extracted the early dates for Churchill and York Factory. Ice movements since 1871 for Churchill and since 1880 for York Factory were in journals of restricted material and so were copied by archives personnel. P. D. Williams, of the National Harbours Board, checked harbour-closing dates at Churchill and gave helpful advice on the criteria used to determine closing dates.

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SOME FACTORS AFFECTING THE MOVEMENT OF FOREIGN TRAFFIC THROUGH SAINT JOHN

J. A. Rayburn

ABSTRACT

Saint John has been part of the national transportation pattern since the turn of the century and in recent years has served one tenth of the traffic passing through Canada's eight national harbours. Most of the Saint John traffic moves during the winter, principally to and from central Canada, and its seasonality causes many local problems. Mainly because of the freeze-up of the St. Lawrence River, the port depends heavily upon extra-regional traffic and thus plays a precarious alternate role rather than a viable one in its own right. Its year-to-year traffic, however, is generally assured because of rate agreements and adjustments among the rail and water carriers.

RÉSUMÉ

Saint-Jean fait partie du vaste complexe des transports au Canada depuis le début du siècle; ces dernières années, il a manutentionné un dixième du trafic-marchandises empruntant les huit ports nationaux canadiens. Le gros du trafic de Saint-Jean se fait l'hiver, surtout en provenance et à destination du Canada central, et ce caractère saisonnier pose plusieurs problèmes locaux. Comme le fleuve gèle en hiver, de nombreuses expéditions destinées à des régions lointaines sont acheminées par Saint-Jean, ce qui donne à ce port un rôle de suppléant essentiellement précaire plutôt qu'un emploi régulier. Toutefois, le trafic y est généralement assez intense d'une année à l'autre, grâce aux accords et ajustements tarifaires entre les chemins de fer et les compagnies de navigation.

INTRODUCTION

The National Harbours Board, which manages the Port of Saint John, one of Canada's eight national harbours, requested the Geographical Branch in February 1962 to examine the origin and destination of the port's foreign traffic. In December 1963 the Branch submitted a report to the Board, which published a summarized report the following August (Rayburn, 1964). The most notable factors in the establishment of the port as an economic and geographic entity were of particular interest to the Branch and are discussed in this paper.

Through Saint John, one of Canada's two national ports on the Atlantic seaboard, passes some 3.2 per cent of the foreign trade of all Canadian ports (Dominion Bureau of Statistics, 1962). Saint John's 1962 tonnage, which amounted to 3.7 million (Figure 2), represented roughly 10 per cent of the international water-borne cargo moved through the national harbours and ranked the port fourth—after Montreal, Vancouver and Halifax but ahead of Quebec, Trois-Rivières, Chicoutimi and Churchill.

Although its volume of cargo has nearly doubled in recent years, chiefly owing to crude-petroleum imports, the Port of Saint John has found its relative position in Canada's external general-cargo trade declining. The decline has occurred largely because about nine-tenths of the general-cargo traffic originates in, or is destined for, extra-regional centres. These centres are being increasingly better served through ports of the St. Lawrence system that have ocean freight rates comparable to those quoted at Saint John, while changes in the rail-freight-rate structure have made Saint John less attractive as a continental entrepôt.

This paper analyzes some of the factors that affect the movement of international water-borne traffic through the Port of Saint John, treating them under internal and external relations, seasonality of traffic, competition, and rate agree-

MS submitted April 1964.

FIGURE 1
Port of Saint John, New Brunswick.

ments and adjustments. Not discussed—partly because they are ungeographical and partly because data to measure them are unavailable—are the regional and national economy, federal transportation policies, local promotional activities, types and efficiency of labour, the physical site, the availability of facilities, the depth of berths, and the efficiency of ship turn-around.

The source of data for this study was the shipping manifests compiled for the National Harbours Board by the land- and ocean-carrier representatives. The data, tabulated for the period of November 1960 to April 1961 inclusive, were processed by electronic computer.

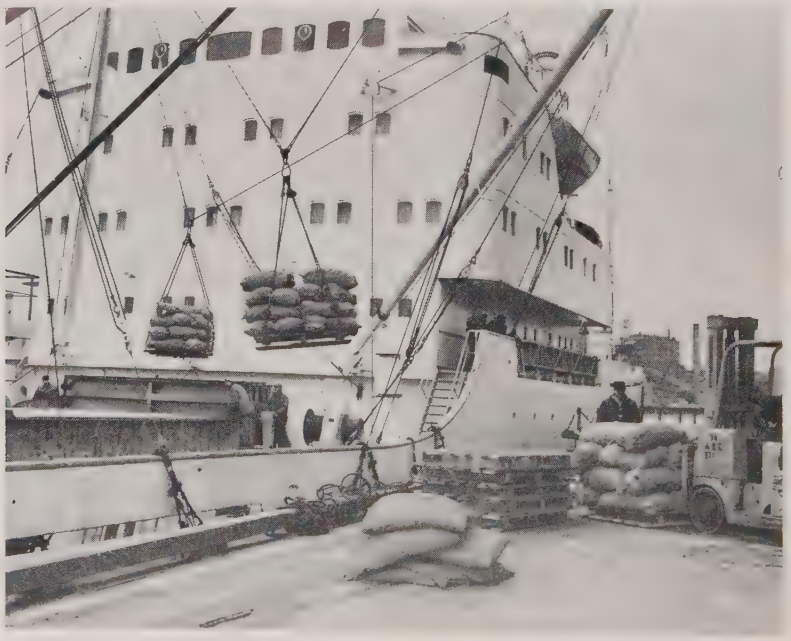

FIGURE 2
One of Saint John's main exports—potatoes—destined for Latin America. (Photo courtesy National Harbours Board, Harvey Studios, Saint John)

A comparison of the computer output data with the statistics provided by the National Harbours Board in its annual reports for the full years 1960 and 1961 revealed similarities in the proportions of the main commodities. The computer data are therefore a sound basis for a valid appraisal of the continental and overseas associations of the Port of Saint John for the early part of this decade.

INTERNAL AND EXTERNAL RELATIONS

Situation

In few other countries are great ports so far removed from their principal markets and exporting centres. Saint John is nearly 500 miles east of Montreal, and nearly half this distance is through the state of Maine. Toronto is more than 800 miles away, and to Winnipeg, at the eastern periphery of Canada's wheat-producing area, it is more than 1,800 miles.

The direct route through Maine is provided by the Canadian Pacific Railway. Saint John is also served by the Canadian National Railways, which reach the Maritimes by an all-Canada route, the distance between Montreal and Saint John being nearly 750 miles. The most direct highway route from central Canada is the main Quebec road from Quebec City to a point just west of Rivière-du-Loup and thence south via Rivière-Bleue, Edmundston and Fredericton.

The port's situation on the Atlantic coast is adjacent to one of the world's busiest trade routes, the transatlantic route between the United States seaboard and northern Europe. It is also in a good position, along with Halifax, to provide Canada with economic links with the Caribbean, South America and Africa.

Export hinterland

Matheson, in a paper on the hinterland of Saint John (1955, pages 88 and 89), concluded that in Canada there were three hinterland divisions for exports, each exhibiting distinctive characteristics. Her remarks concerning these main divisions—the Atlantic region, the Quebec-to-Windsor industrial heartland and the West—are equally valid today.

During the selected period of study, Saint John was the outlet for 1,205,199 tons* of cargo, of which 45 per cent was grain from western Canada. The Atlantic Provinces provided only 16 per cent of the remaining (miscellaneous, hereinafter called "general") cargo (Figure 3). The industrial heartland was the source of a little more than half of the general-cargo exports.

*The tons referred to in this paper are those of 2,000 pounds and 40 cubic feet.

FIGURE 3. Grain elevators, National Harbours Board, Saint John, illustrating—grain. Note most important general-cargo import—motor vehicles—in foreground. (Photo courtesy National Harbours Board, Harvey Studios, Saint John)

As a source of exports, the Atlantic region was dominated by forest, farm and fish products and, according to the main commodity groupings of the Dominion Bureau of Statistics, provided about one fifth of the food and fabricated materials that passed through the port during the selected period. The region's earth-extractive industries, on the other hand, were depressed, as indicated by the fact that the region provided only 6 per cent of the crude materials thus exported; and the relative smallness of its manufacturing base was emphasized by its less-than-one-tenth participation in the exports of manufactured products.

From the province of Quebec outside Montreal came more than half the crude materials (aluminum, asbestos, logs) and a quarter of the fabricated materials (newsprint, wood pulp, other products of the paper industry) shipped abroad through Saint John. Ontario west of Toronto supplied one quarter of the manufactured end products, one quarter of the food products, one fifth of the fabricated materials and one tenth of the crude materials.

Thirteen per cent of the exports originated in Montreal and consisted principally of flour and refined copper. Toronto provided only 6 per cent, which was chiefly agricultural, consisting of commodities such as oil cake and grain products.

Apart from grain, western Canada's share in the export trade at Saint John was made up principally of flour, zinc spelter, petrochemicals and brick and amounted to 35,560 tons. Slightly more than 2 per cent (15,660 tons) of the general-cargo export trade, consisting mostly of automobiles and parts, hides and leather, flour and dried vegetables, originated in the United States, chiefly in the Midwest.

Import hinterland

The imports unloaded at Saint John from November 1960 to April 1961 inclusive amounted to 1,548,478 tons.

The bulk cargo totalled 1,230,730 tons and was entirely for delivery in Saint John. It consisted chiefly of crude petroleum for the Irving Refinery and raw sugar for the Atlantic Sugar Refinery. Also carried in bulk were petroleum fuel, refined petroleum and molasses.

The general cargo amounted to 317,748 tons. Only 7 per cent of this was retained in the Atlantic region, 81 per cent being destined for the industrial heartland and 6 per cent for the United States Midwest (Figure 4).

Contrary to the conclusion drawn by Matheson (1955, page 75), the import hinterland was not as broad as the export hinterland. It was concentrated in a few of the main centres, thus re-

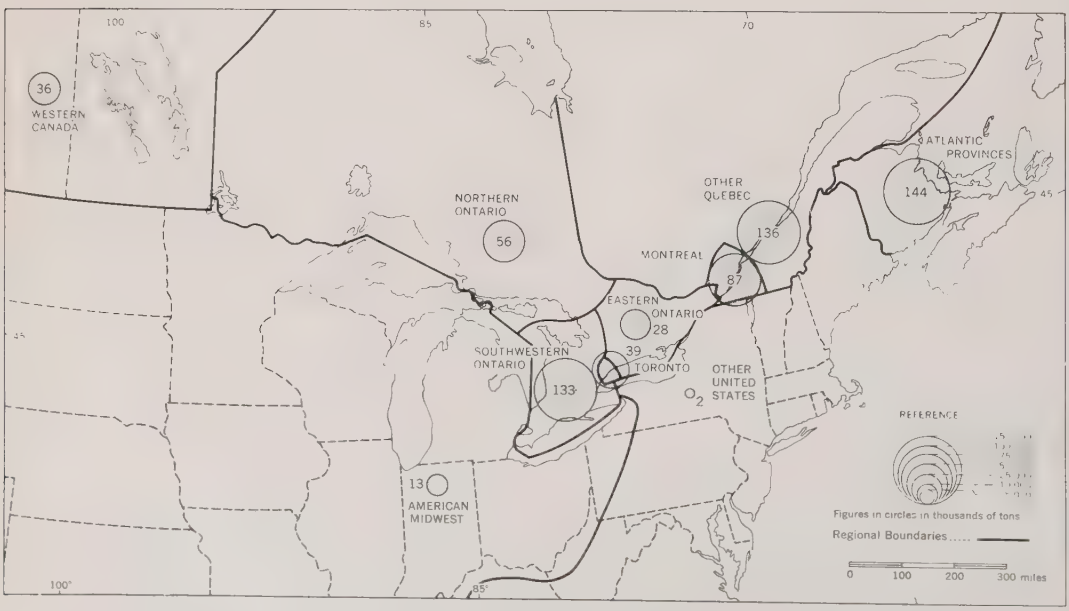

FIGURE 4. Origin of foreign general cargo exports loaded at Saint John, November 1960 to April 1961

flecting the influence of the specialized importing and distributing establishments.

In the import of partly or wholly processed goods, the region adjacent to the port was weak: only 22,005 tons of the incoming general cargo that arrived during the November-April period of 1960-61 remained in the area. About half of this was made up of motor vehicles; the rest consisted of fertilizer, chemicals, machinery, iron and steel products and alcoholic beverages. Two thirds of this general cargo stayed in Saint John; most of the remainder was shipped to Moncton, Fredericton, Amherst, Truro and Halifax.

Four fifths of the general cargo destined for the Canadian heartland was for delivery in Montreal and Toronto. Their pre-eminence was due chiefly to automobile imports, which amounted to 87,282 tons (two thirds of the imports of this commodity). These centres received large volumes of other commodity items, particularly textiles and tropical-food products for Montreal and glass and machinery for Toronto. Outside Montreal and Toronto the principal heartland destinations for import cargo were Oshawa (automobiles) and Hamilton.

The Canadian West was the destination of only 7,579 tons, two thirds of which was delivered in Winnipeg. The United States imported considerably more (28,245 tons) through Saint John than it exported. The leading importing centres were Detroit (automobiles, glass, alcoholic beverages), Chicago (glass, alcoholic beverages, dried fish), New York (jute), Boston (jute), and Cleveland, Toledo, Cincinnati, St. Louis and Minneapolis (a variety of items).

*Export foreland**

Saint John is more favourably located in relation to its main overseas market than to its hinterland. Three quarters of the traffic originating in Canada and more than four fifths of the traffic from the United States was destined for British and continental ports. More than 10 per cent of Canada's exports shipped via Saint John were for delivery in Caribbean and South American ports.

The distribution of the exports loaded at Saint John from November 1960 to April 1961 reaffirms Canada's traditional markets, which are its Commonwealth partners and the better developed of the other nations. Shipments to British and continental ports were dominated by huge volumes of grain, significant tonnages of which were also shipped to Albania, Arabia, India and Burma. Large volumes of general cargo were delivered not only to Japan, Australia,

*Defined by Weigend (1956) as the areas connected with a port by means of ocean carriers.

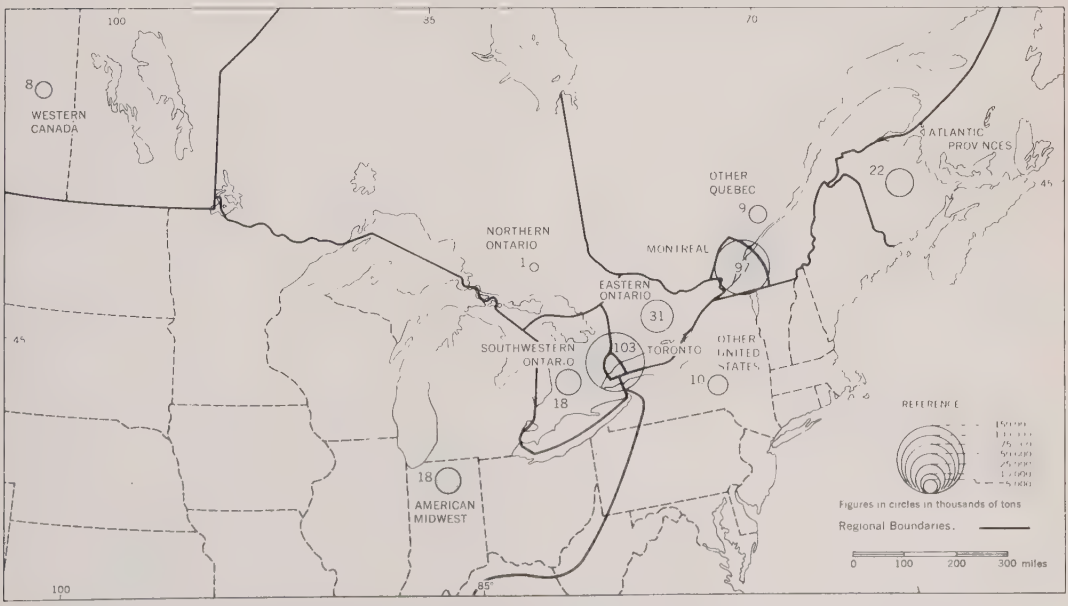

FIGURE 5. Destination of foreign general cargo imports unloaded at Saint John, November 1960 to April 1961

New Zealand, southern and eastern Africa and southern Asia—countries and areas with which Canada has traditional export ties—but also to European, Caribbean and eastern South American countries. Saint John had very little export contact with Scandinavia, eastern Europe, the Middle East, northern Africa, western South America or southeast Asia.

Import foreland

Asia provided 70 per cent of Saint John's import traffic, but most of it was crude petroleum from Iran and Lebanon. Europe was the source of 17 per cent of the cargo, and the Caribbean countries and Australia provided most of the remainder.

The influence of the preferential trade agreements with Commonwealth countries is evident in the volumes of general cargo from the United Kingdom, India, Ceylon, Kenya, Jamaica, Australia and New Zealand. Only the Caribbean, Australia, Sweden, Poland, and the United States had stronger import than export associations with Canada. Eastern South America and the Mediterranean were relatively weaker in import ties. Again, the associations between Saint John and western South America, northern Africa, eastern Europe, the Middle East and southeast Asia were either weak or non-existent.

SEASONALITY OF TRAFFIC

A problem of long standing at the Port of Saint John is that traffic fluctuates from month to month, primarily with the availability of shipping in the St. Lawrence. This has meant that a $40-million complex of wharves and sheds is used throughout the year at only one third of its capacity. In addition, the tremendous variability of traffic has undoubtedly brought hardship to those employed in transferring goods from land to ocean carriers and has contributed, to a certain extent, to the instability of the local economy, which is reflected in the relatively poor urban landscape.

Export traffic

The export traffic at Saint John exhibits an enormous variation between winter and summer. The 447,620 tons of grain that passed through the port during January, February and March of 1961 represented 76 per cent of the entire year's volume of grain and was only 27,300 tons short of the volume of grain shipped during the whole of 1960. The fluctuation of general-cargo traffic in 1961, when 81 per cent passed through the port during January, February and March, was even more striking. More general cargo moved in each of these months than in the other nine months of the year combined.

During December 1960, the export traffic was slightly more than 100,000 tons. Most of it originated in central Canada, where the winter freeze-up of the intervening ports was expected. The following April, traffic fell to 70,000 tons, two thirds of which was grain. That month's shipments had most likely been consigned before the opening of the St. Lawrence system. November's traffic of 22,450 tons consisted entirely of Maritime shipments of potatoes and lumber, and this volume was probably representative of the months from May to October.

Import traffic

During the period selected for study, the import traffic was uniform in volume from month to month. The reason was that 80 per cent of it consisted of bulk commodities such as crude petroleum and raw sugar, which are brought into Saint John without regard to season or the opportunity of using intervening ports with special handling facilities nearer the markets.

The traffic flow of general-cargo imports varied like that of general-cargo exports. During January, February and March 72 per cent of the general-cargo imports for the period arrived at Saint John. February alone had as much general cargo as all the months from April to December combined.

COMPETING PORTS

Halifax

Although the ports of Halifax and Saint John are managed by the National Harbours Board, competition between them in the regional and continental hinterlands, at the levels of both management and the city-operated port commission, is intense. The two cities co-operate, however, in sponsoring an annual conference on mutual problems.

Saint John, owing to its larger hinterland for forest industries and potatoes (Patton, 1957), has a greater volume of regional exports. The general-cargo import traffic for both ports is about the same during the summer, but Saint John's volume increases during the winter. In that season also, the New Brunswick port has twice the general-cargo export traffic of Halifax (Vorstermans, 1963b). Saint John predominates

in the export of grain largely because it has more berths equipped with conveyors and consequently greater flexibility for the peak-season loading of liners, which occurs in winter. Halifax monopolizes the southeast Asia traffic entering Canada with Commonwealth preference.

In some ways Halifax and Saint John are complementary. From the former, situated on the main North Atlantic route, Europe can be reached in shorter sailing time. Saint John is more favourably situated in relation to central Canada, being 482 miles and 24 hours by rail from Montreal, whereas Halifax is 811 miles and 32 hours from Canada's principal shipping centre. For inland transit Halifax is served almost exclusively by the Canadian National Railways, while overland transport to Saint John from central Canada is dominated by the Canadian Pacific Railway.

Inland ports

The Port of Saint John was established as part of the national transportation system on the presumption that the St. Lawrence River was not navigable in winter. During the last 10 years, however, there *has* been winter navigation and it has been increasing. Throughout the winter of 1963-64 one shipping line operated a scheduled service right up to Montreal.

Port employers and promoters in the Maritimes are understandably anxious about this trend in Canada's international water-borne commerce. The Port of Halifax Commission has estimated that the Atlantic ports' share of Canada's winter export traffic dropped from 86 per cent to 62 per cent between 1957 and 1962 and their share of the import traffic from 68 per cent to 43 per cent (Port of Halifax Commission, 1963). The Atlantic Development Board, a federal agency set up late in 1962, has launched a full investigation of traffic losses suffered by Atlantic ports through the increase in winter navigation on the St. Lawrence.

Various observers believe that the St. Lawrence Seaway did not initially have an adverse effect on the Atlantic ports (Economic Research Corporation, 1960; Mitchell, 1963; Vorstermans, 1963a; Dickson, 1963; Patton, 1957). They note, however, that the stimulation of the Seaway is making more economical the stockpiling of some companies' goods at inland ports and that it will probably encourage shipping lines to extend their Great Lakes schedules and the frequency of their Great Lakes port calls. For these reasons, the observers believe that the Atlantic ports will participate only moderately in any increase in trade.

United States ports

Because of the railways' adherence to freight-rate-parity agreements, Saint John has been able, for a number of years, to compete successfully with seaboard ports in the United States for traffic from that country's Midwest. United States import and export traffic moving through Saint John amount to between 40,000 and 50,000 tons a year, and almost all of it is oriented to the transatlantic routes. The various shipping lines that secure their cargoes at Great Lakes ports during the summer possibly encourage the use of the Saint John route, fearing that if their winter traffic from the Midwest is allowed to go through United States seaboard ports, it will be lost permanently.

In 1960, the most recent year for which data are available, more than 6 per cent of the value ($143.2 million) of Canada's international export traffic other than that destined for the United States was shipped through United States ports (Dominion Bureau of Statistics, 1960). On the other hand, these ports were used for less than 1 per cent of the value of Canada's water-borne imports, apart from petroleum delivered by the Montreal-Portland pipeline, commodities originating in the United States, and Central American produce moved through Mexico or handled, like bananas, at New York by means of special facilities in United States ports (Vorstermans, 1962). Among the reasons for this routing of Canadian shipments are the following: (1) greater frequency of sailings from United States ports and to foreign destinations; (2) parent companies domination of the movement of trade outside Canada; (3) the availability of special facilities; (4) the establishment of letters of credit in New York banks; (5) superior promotional efforts of United States port agencies, railways, shipping companies, forwarders and brokers; and (6) the practice followed by some shipping lines of making the first and last calls at New York. Recent efforts of the Canadian Port Committee to discourage the use of United States ports for Canadian overseas trade are showing signs of success (National Harbours Board, 1964).

RATE AGREEMENTS AND ADJUSTMENTS

Because of the rate agreements in effect among many ocean shipping lines, the expense of ship-

ping to or from Saint John is generally on a par with that of shipping to or from inland or other eastern-seaboard ports. The complexities of ocean freight rates nevertheless make it impossible to state clearly whether the position of Saint John in relation to other Atlantic ports is advantageous or disadvantageous. Some responsible observers contend that the Saint John rates are, on the whole, lower than those on shipments through United States ports (March, 1963; Dickson, 1963); others believe that ocean rates from Canadian ports tend to be higher (Vorstermans, 1963a; Britton, 1963).

Compared with inland ports, Saint John is at a rate disadvantage. At the inland port of Montreal, for example, while ocean freight rates are comparable to those offered at the Atlantic ports, rail export rates are generally two cents a hundred pounds less, and for some commodities the difference may be as high as 15 cents.

Half a million tons of grain exports pass annually through Saint John. The movements have depended not only upon the elevator capacity of the port and winter freeze-up on the St. Lawrence, but also upon special rates that have maintained parity between the cost of shipping grain from such Ontario points as Port McNicoll and Port Colborne to Saint John and the cost of shipping it from Buffalo to United States ports. In February 1961, having estimated that the railways were annually losing $2 million in revenue, the Board of Transport Commissioners authorized a series of rate increases averaging 25 per cent. Since then, by order of the federal cabinet, the proposed increases have been suspended at six-month intervals. The Maritimes Transportation Commission (1961) has pointed out that the proposed rate changes for shipments to Saint John and Halifax could mean a net increase of 58.8 per cent from points west of Prescott, Ontario, and of 62.4 per cent from points east of Prescott. The ensuing estimated losses could substantially reduce the number of grain cargo ships at present entering Saint John.

To some extent the Port of Saint John derives benefit from the Maritimes Freight Rates Act, which was introduced in 1927 to allow eastern shippers a rail-freight-parity with central Canadian industries. Export shippers east of Quebec City are given a 20-per-cent reduction on freight charges on the haul to an Atlantic port. Imports that are processed east of Quebec City, such as sugar, can be shipped into central Canada at a 30-per-cent reduction on charges on the haul to Quebec City. The M.F.R.A. applies only to railways, but the MacPherson Royal Commission has recommended its extension to road, water and air carriers (MacPherson et al. 1961).

SUMMARY

The role of Saint John as part of the national transportation pattern has been determined by many factors, some of which have been covered in this paper. As an alternative to Montreal, it was developed at the turn of the century to receive and ship international water-borne cargo during the winter, and this role has continued to be its principal function. Its traffic has thus been restricted, in the main, to January, February and March.

Only a comparatively small part of the port's traffic movement occurs within the Atlantic region, about 9 of every 10 tons of its cargo volume coming from or moving to other areas of the continent. Most of the local traffic is made up of exports of forest products and potatoes and imports of petroleum and sugar. In addition, Saint John has to compete with the port of Halifax, whose functions are similar. In the movement of Canadian trade, the competition of United States ports must also be contended with. On the other hand, Saint John receives a substantial volume of United States traffic, which is oriented mostly to the Great Lakes industrial centres.

Rate agreements and adjustments among the ocean and land carriers generally give assurance that the port of Saint John will have a regular flow of traffic from year to year. The port, however, unlike others that are more favourably situated, is peripheral to the continent's markets and industrial areas. Thus, when freight rates change, they often do so to its detriment.

MS submitted April, 1964

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THE GEOGRAPHY OF THE ORCHARD INDUSTRY OF CANADA

Ralph R. Krueger

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ABSTRACT

The orchard industry of Canada is discussed under these aspects: orchard trends and economic conditions; the development of regional specialization; and the delimitation of orchard regions. There follows an analysis of the location, land type, climate, orchard trends and economic conditions of each of the principal orchard regions of Nova Scotia, New Brunswick, Quebec, Ontario and British Columbia.

The conclusion is reached that in these five provinces the physical environment is suitable for a substantial expansion of the apple orchard industry. The physical resources for the soft-fruit industry are much more limited. The most tender of the soft fruits—apricots, peaches and sweet cherries—can be produced successfully on a large scale only in the South Okanagan of British Columbia and the Kent-Essex region and Niagara Fruit Belt of Ontario.

The greatest problems of most of the Canadian orchard industry are related to marketing. They arise from the uncertainty of foreign markets, poor distribution to domestic markets, competition from imports, and low prices for produce in the face of constantly rising production costs. The recommended solution is more orderly marketing procedures supported by a central selling agency similar to the one that exists in British Columbia.

RÉSUMÉ

L'auteur étudie dans la présente étude l'arboriculture fruitière sous les angles suivants: les tendances et la situation économique de la fructiculture, la spécialisation régionale, et la délimination des régions fruitières. Ensuite vient l'étude de l'emplacement, du genre du sol, du climat, des tendances et de la situation économique de chacune des principales régions fruitières de la Nouvelle-Écosse, du Nouveau-Brunswick, du Québec, de l'Ontario et de la Colombie-Britannique.

Le milieu physique des cinq provinces précitées est favorable à une forte expansion des vergers de pommiers. Les possibilités de culture industrielle des fruits tendres sont bien plus limitées. On peut produire avec succès les fruits à noyaux les plus tendres (abricots, pêches et cerises à chair douce) sur une grande échelle dans les seules régions suivantes: le sud de la vallée de l'Okanagan (C.-B.); la région du Kent et de l'Essex et la zone fruitière du Niagara (Ont.).

La mise sur le marché est à l'origine des plus grandes difficultés auxquelles se heurte l'arboriculture fruitière canadienne. Elles proviennent de l'instabilité des marchés étrangers, une mauvaise répartition sur le marché intérieur, la concurrence des importations, et le fait que les prix de vente des produits sont bas en comparaison de l'augmentation continuelle des coûts de production. L'auteur recommande comme solution une mise sur le marché mieux coordonnée et soutenue par une organisation centrale de vente semblable à celle qui existe en Colombie-Britannique.

INTRODUCTION

Membership in a Government of Ontario research team making a detailed land-use study of Louth Township, in the heart of the Niagara Fruit Belt, introduced the author to geographical research relating to orchards (Irving, 1957). The survey provided the incentive for a further study of the physical and economic basis of the orchard and vineyard industry of the whole Fruit Belt, with emphasis on the effects of urban expansion into the fruitland (Krueger, 1959 and 1960). It was then decided to undertake a study of Canada's other orchard regions in the hope of putting the national significance of the Fruit Belt in better perspective and, at the same time, making a worthwhile contribution to the literature on the agricultural geography of Canada.

In 1956, Professor C. W. Olmstead published a paper entitled "American Orchard and Vineyard Regions," but limited its scope to the United States. The present paper complements the Olmstead study by covering the northern part of North America. It does not, however, include vineyards, 95 per cent of which are in the Niagara Fruit Belt.

The research on which this report is based was carried out for the Geographical Branch during the five summers of 1959-63. During those periods, while interviews were being conducted and observations taken, every orchard district in Canada was visited. In addition, data both published and unpublished were collected from provincial and national government agencies and fruit growers' organizations.

THE CANADIAN ORCHARD INDUSTRY

ORCHARD TRENDS AND ECONOMIC CONDITIONS

About the turn of this century, orchards were planted extensively in British Columbia and eastern Canada. Plantings reached their greatest

extent by 1911, and the *Census of Canada* for that year records almost 16 million apple trees. A decline began during World War I and has continued ever since. Canadian orchards, which in 1921 covered 297,000 acres, had been reduced by 1961 to about 148,000 acres.

Despite the decline in acreage, tree-fruit production in Canada has been constantly increasing. While the number of apple trees, for instance, has decreased by 50 per cent during the last 30 years, the average annual apple production has edged upward from a little more than 11 million bushels for 1928–32 to about 17 million bushels for 1958–62 (Figure 1). An output of more than 20 million bushels recorded for 1962 and again for 1963 indicates that apple productivity may continue to increase for some time.

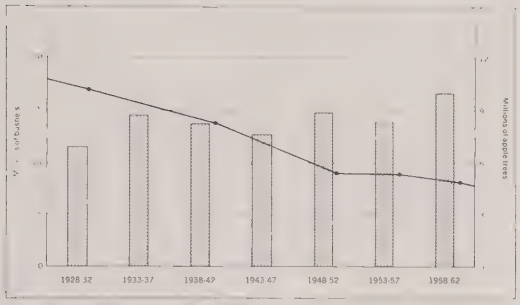

FIGURE 1. Apple production and numbers of trees in Canada, 1928-62. Each bar represents the average annual production for a five-year period; the line represents the number of apple trees. The raw production data are from the Dominion Bureau of Statistics, and the numbers of apple trees are from its *Census of Canada*, 1961. Up to 1941, all orchard trees were enumerated; from 1951 on, the only orchards recorded were those with 25 or more trees.

On the basis of *Census of Canada* statistics, there are now more than 148,000 acres of orchard in Canada. Ontario has the largest share and is followed, in order, by British Columbia, Quebec, Nova Scotia, and New Brunswick (Figure 2). The fruitlands found in Prince Edward Island and in each of the Prairie Provinces total no more than a couple of hundred acres and constitute either small scattered farmstead orchards or experimental orchards such as the ones at the agricultural research station at Morden, Man.

Table 1 illustrates the difficulty of obtaining the acreages of commercial orchards. In the *Census of Canada* an attempt is made to eliminate nonproductive orchards by including only those of 25 or more trees. The census table that includes the orchards on *commercial* farms only (those that sold more than $1,200 worth of produce in 1960) shows about 20,000 acres less than the table that gives the orchard area for *all* census farms. The third column of Table 1 is the writer's attempt at a realistic estimate of commercial-orchard acreage. For British Colum-

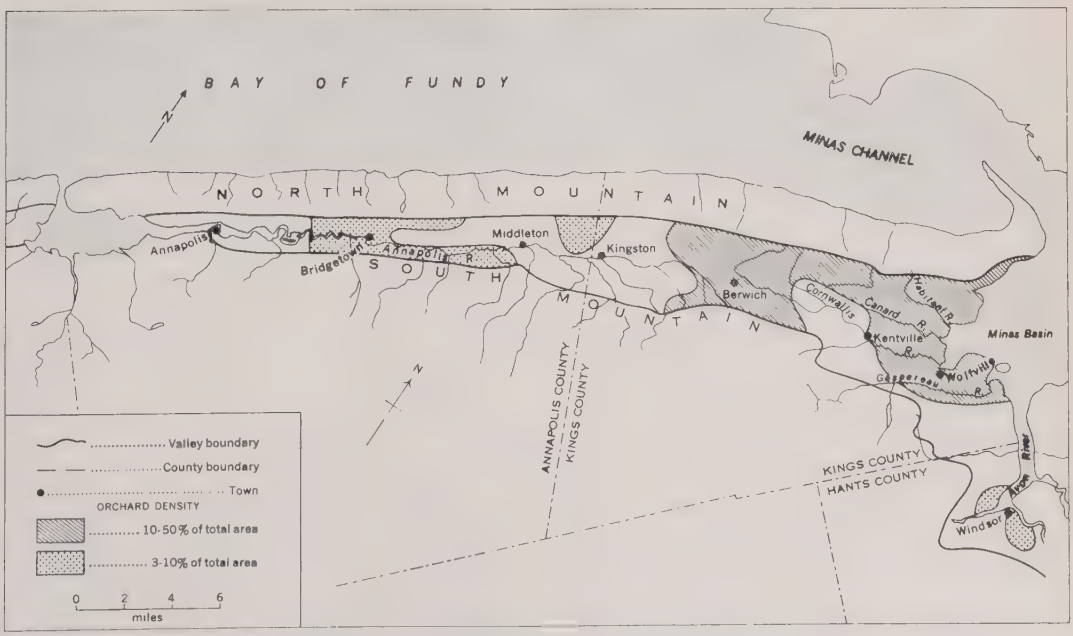

FIGURE 2. The orchard region, Annapolis Valley, Nova Scotia.

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bia and Ontario, the commercial acreage is that obtained in recent provincial orchard surveys. In New Brunswick, the survey was modified to eliminate scattered submarginal or non-commercial orchards in areas outside the Saint John River valley. In Nova Scotia and Quebec, field checks indicated that in counties with less than 200 acres of orchard, the commercial-orchard acreage was insignificant. Thus, in those two provinces, the commercial-orchard total was estimated by excluding from the *Census of Canada* total all counties with less than 200 acres of orchard.

Table 1

Canadian orchard acreages, by province

Province	All orchards[1]	Orchards on commercial farms[2]	Commercial orchards[3]
Nova Scotia	13,200	11,700	12,800
New Brunswick	2,400	1,700	2,000
Quebec	25,700	21,900	19,200
Ontario	68,700	60,700	51,500
British Columbia	37,200	30,500	34,900
Total	147,200	126,500	120,400

[1]From the *Census of Canada*, 1961, "Agriculture", bulletin AA-4, Table 17, which includes all orchards with 25 or more fruit trees.

[2]From *Census of Canada*, 1961, "Agriculture", bulletins 5. 1-4 (Nova Scotia), 5. 1-5 (New Brunswick), 5. 2-1 (Quebec), 5. 1-4 (Ontario) and 5. 3-4 (British Columbia), Table 37, which includes only orchards on farms whose 1960 produce sales were worth more than $1,200.

[3]Commercial orchard acreages for Nova Scotia and Quebec are estimated by excluding all counties with less than 200 acres of orchard from the total given in the *Census of Canada*, 1961, "Agriculture", bulletin AA-4. The New Brunswick, Ontario and British Columbia acreages are based upon recent provincial orchard surveys.

Further difficulties in working with orchard statistics resulted when, in 1961, the Dominion Bureau of Statistics stopped giving the acreage for individual tree fruits. It is difficult to convert tree numbers into acreages accurately because the number of trees per acre varies from place to place and changes from time to time in the same place. The task is further complicated by the alternate planting of different kinds of fruit trees and the trend toward dwarf and semidwarf apple trees, which requires much less space. The acreage totals shown in Figure 1 have been taken directly from the *Census of Canada*. For Nova Scotia, New Brunswick and Quebec, the tree crop of each kind has been computed as a percentage of the whole orchard crop on the basis of the number of trees shown per acre in each province for 1951, when both the number of trees and the acreage were given for each tree crop. The individual tree-crop acreages for Ontario and British Columbia are based upon the provincial orchard surveys.

In 1960, farm sales of tree fruits were worth about $37\frac{1}{2}$ million. More than 80 per cent of these fruits were produced in Ontario and British Columbia.

Apples, in both acreage and value of production, are the most important element in the Canadian orchard industry, but the provinces have not shared equally in the increase that has occurred in Canadian apple production since the 1920's (Table 2). From the production period of 1928–32 to that of 1958–62, the Maritimes dropped from 37 per cent of the total to only 16 per cent. In the same interval, Quebec's share increased fivefold, from 5 per cent to 25 per cent. Ontario's share of the national apple production fell slightly in the late 30's, but rose again until, in 1958–62, it reached 28 per cent. British Columbia's share rose from 32 per cent for 1928–32 to 49 per cent for 1948–52, and then declined to 31 per cent for 1958–62. These provincial trends are explained later.

Canadians, who since their school days have heard of their country's famous apple regions, may be surprised to learn that Canada contributes only 2 per cent of the world's apple output and ranks tenth as a world producer (Table 3). The reduction that has occurred in Canadian apple exports to Britain since the late 1930's, when that country obtained 40 per cent of its apple imports from Canada, is partly explained by the fact that in the same period world apple production has almost doubled. By the early 1950's, Canada's share of the British market had been reduced by European competition and currency problems to 7 per cent, but in recent years this share has risen to about 20 per cent. The United Kingdom, however, now imports less because its own apple production has greatly increased. Since the 1930's, in addition, it has received between 3 and 4 million bushels a year from Australia and New Zealand combined; and during the 1958–62 period its imports from South Africa and Italy, which in the 1930's were negligible, increased to more than $1\frac{1}{2}$ million bushels a year. In the early 1960's, on the other

Table 2

Average annual apple production in Canada and percentage by provinces, 1928-62

Production period	Canada (millions of bushels)	Percentage of Canadian production			
		Maritimes	Quebec	Ontario	British Columbia
1928–32	11.5	37	5	21	32
1938–42	13.7	36	6	17	41
1948–52	14.7	18	13	20	49
1958–62	16.5	16	25	28	31

Source: Dominion Bureau of Statistics, Ottawa.

Table 3

Average apple production[1] for 10 leading countries and world[2] in selected five-year periods

(millions of boxes, dessert, cooking and cider apples)

Country	1935-39	1953-57	1958-62
France	164.5	140.1	194.8
United States	127.3	106.7	121.8
Italy	12.9	48.9	84.0
West Germany	36.1	51.6	75.1
Japan	7.6	26.4	39.1
United Kingdom	10.6	21.9	28.7
Switzerland	16.5	16.7	24.4
Argentina	1.4	14.4	20.1
Austria	7.1	12.8	18.9
Canada	14.6	14.8	16.4
Total (World)	461.1	547.8	806.6

[1]From *Information Relating to World Production and Trade in Deciduous Fruits*, Foreign Agricultural Service, U.S. Department of Agriculture, Washington, 1962.

[2]The world total includes production from 25 countries with an average annual output of more than 1 million boxes.

hand, Canada's apple exports to the United Kingdom have averaged only about 1 million bushels annually. The reduction in these exports has been partly offset in recent years by an increase in exports to the United States. In three of the five years of 1958-62, Canada shipped more apples to the United States than to the United Kingdom.

Since World War II the domestic outlets for processed and fresh fruit have become more important to the Canadian apple industry than export markets. In the 10 years from 1952 to 1962, exports accounted for only 15 per cent of each year's apple sales. In the same period, 25 per cent of the apple output was processed and 60 per cent was sold as fresh fruit in Canada.

The production of soft fruits in Canada has, on the average, more than doubled since the 1930's. Pears have shown the greatest increase. The only significant reduction in the last decade has been that of plums and prunes.

Table 4

Annual average of soft-fruit production in Canada and provincial percentage, 1958-62

Tree fruit	Canada (thousands of bushels)	Percentage of Canadian production			
		Nova Scotia	Ontario	Quebec	British Columbia
Peaches	2,695	0	78	0	22
Pears	1,506	3	58	0	39
Cherries	634	0	79	0	21
Plums and prunes	545	1	58	0	41
Apricots	258	0	0	0	100

Source: Dominion Bureau of Statistics, Ottawa.

The bulk of Canada's soft fruit has always been grown in Ontario and British Columbia. In 1958-62 Ontario produced more than three-quarters of Canada's peaches and cherries, more than half its pears and more than half its plums and prunes. British Columbia produces virtually all the apricots. This is all shown in Table 4.

About half the Canadian soft-fruit output goes into processed products. Most of the remainder is sold on the domestic fresh-fruit market. In the past, exports of soft fruits were insignificant, but recent efforts made by both government and industry have substantially increased the export of canned fruits. Between 1951 and 1961, for example, Canada exported canned pears at an average rate slightly exceeding 1 million pounds a year. In 1962, the export of canned pears amounted to more than 7 million pounds (Canada, Department of Agriculture, 1961–62).

The creation, in 1963, of the central selling agency, Fruit and Vegetable Export Sales Limited (Favexsales), is likely to result in a further increase in the export of Canadian soft fruits.

DEVELOPMENT OF REGIONAL SPECIALIZATION

Everywhere, except in the Prairie Provinces, one of the first farm activities of an early Canadian settler was usually the planting of a few apple trees to provide his family with much-needed fresh fruit during the fall and winter. Where the climate was more favorable, orchards were enlarged year by year until they not only met family needs but provided a welcome cash crop. Thus orchard cultivation became a part of the mixed-farm operation.

The present orchard regions of Canada evolved from these farmstead enterprises, the only exception being the Okanagan Valley, where the agricultural economy changed abruptly from livestock-grazing to the cultivation of commercial orchards. As the domestic demand increased and quality standards rose, and as Canada began to export apples to European markets, only those who provided better varieties and improved their methods of cultivation were able to survive the competition. It did not pay the farmer to buy expensive equipment unless he enlarged his orchard. To get the best possible returns on his investment and labor, the grower had to become expert at such procedures as insect and disease control, pruning, grafting, thinning, tilling, fertilizing, harvesting, storing and selling.

In areas with sufficiently moderate winters, the choice before the general farmer lay between expanding his orchard into commercial operation and abandoning it. The collective decisions made by farmers in any given region led either to orchard specialization or orchard decline. In some areas most of the farmers decided in favor of abandonment; in others the decision was split between specialization and nonspecialization; in still other areas almost all the farmers turned to specialization. Some have combined commercial orcharding with general crop and livestock farming; others have supplemented orcharding with the production of small fruits and vegetables as cash crops.

Geographers are interested not only in realistically describing man's responses to various environments but also in explaining how and why certain regional patterns have developed. It is the task of the geographer to attempt to determine the factors that had the greatest bearing on the land-use decisions made from time to time by groups in given areas. Some of the physical conditions that should be considered are often obvious, but the reasons for the human response to them are usually difficult to ascertain. It is frequently necessary to study historical documents and interview persons who have lived for many years in the region in question. In Canada, where most orchard specialization occurred after the turn of the century, there are many people closely associated with the orchard industry who remember why certain decisions were made.

Olmstead says that in the United States the evolution toward regional orchard specialization depended upon (1) location with respect to market, (2) climate and land type, and (3) a particular desire to specialize in orchards (Olmstead, 1956). The map (Figure 2) seems to show that, because of their proximity to Montreal and Toronto, the main orchard areas in southern Quebec and around Lake Ontario have a decided advantage in the domestic market. Despite this proximity, however, it was the combination of superior land type and favorable climate that influenced the farmers of these two areas to specialize in orchards. Today, in fact, commercial orcharding immediately south of Montreal is declining be-

cause the land is too flat for proper soil and air drainage while orchard regions that are more distant but have superior slope and soil conditions are continuing to increase in importance. In Ontario, likewise, regardless of the location of the main urban centres, the principal orchard areas hug the lakefront because the superior physical conditions found there are considered more important than market proximity. Orchards in the immediate vicinity of Toronto thus have the double advantage of good growing conditions and closeness to market.

Nova Scotia is another example. Its general location in relation to the United Kingdom market was an important factor in leading its farmers' to turn to apple specialization. The scene of this specialization, however, lay amid the superior physical conditions of the Annapolis Valley.

In the Okanagan Valley the orchard industry had to overcome both physical and market-location liabilities. Specialization seems to have received its greatest stimulus from real-estate promotion and from the establishment of large orchards by Lord Aberdeen, who was then Governor General.

Nowhere in Canada is there evidence that orchard regions evolved because of the settlers' particular desire to specialize. Some districts in areas of suitable orchard land and climate turned to orcharding because of the financial success of one or two commercial orchardists. When a farmer found a crop that proved more profitable than any other, many of his neighbors were soon seeking his advice and copying his operation.

Regional orchard specialization brings with it organizations for special research, service, processing, advertising, storage, shipping and selling, with the result that efficiency and specialization tend to increase. So it becomes difficult for a combination of small orchard operators or even a few large establishments to come from outside and compete with growers within the region of specialization. There is thus a growing tendency for orchards to serve smaller areas. This pattern is particularly evident in southern Ontario, much of which is physically suitable for apple cultivation.

Since even the milder areas of Canada approach the poleward limits of the climate in which the less hardy soft fruits can be produced, it is not surprising that physical conditions have been the main determinant of the location of soft-fruit orchards. The Niagara Fruit Belt, the most southwesterly corner of southern Ontario and the South Okanagan are the only areas with winters mild enough for the successful growing of peaches, sweet cherries and apricots. Peaches and sweet cherries are grown in all three areas, but surprisingly, apricots are a commercial product only in the Okanagan. It is generally conceded that apricots could be grown in the Fruit Belt, but early unsuccessful experiments in the region discouraged their extensive planting. Recent successes, however, indicate that the Fruit Belt apricot crop may become more important.

DELIMITING ORCHARD REGIONS

To delimit the orchard regions of Canada, the orchard acreages for 1956 were mapped, by census subdivision, as a percentage of agricultural land. The *Census of Canada* provides orchard statistics for counties but not for the census subdivisions such as townships and parishes. Thus the orchard acreage data had to be obtained from unpublished census data kept on file by the Dominion Bureau of Statistics, Ottawa.

The boundaries of the orchard areas were further refined by the use of air photographs and updated by observations taken in the field. The definition of orchard areas on the basis of 3 per cent and 10 per cent of agricultural land in orchard makes the orchard-region maps of this study roughly comparable with those in Olmstead's paper (Olmstead, 1956). Agricultural land rather than total area has been used as a base because it more accurately delimits orchard areas when the proportion of nonarable land is large.

Olmstead used the hierarchical regional terms "realm," "province" and "district." For Canada, however, where a province is a major political subdivision, his regional terminology is not appropriate. Hence, the areal subdivisions within each political province are indicated in this study by the words "region," "subregion" and "district." Geographical location is usually the chief criterion for the choice of the designation; but for the division of the Okanagan Valley into two orchard regions the chief criteria were the differences between the northern and the southern areas in climate and in crop combinations. In Canada, the districts are generally named after town centres, and most of the names are traditional in these orchard areas.

The sections that follow are a description of Canada's main orchard regions. Because the available information was not all adequate, the descriptions are not all equally detailed nor are they in all cases comparable.

THE ORCHARD INDUSTRY OF THE ANNAPOLIS VALLEY, NOVA SCOTIA

LOCATION, LAND TYPE AND CLIMATE

Commercial orchards in Nova Scotia are concentrated almost entirely in the Annapolis Valley, a long narrow stretch extending some 70 miles from Annapolis Basin on the west to Minas Basin on the east (Figure 2). Its width ranges from about 2 miles at Annapolis Royal to about 8 miles at Wolfville. The western two thirds of the valley is drained by the Annapolis River, and the eastern third by the Cornwallis and Avon rivers as well as by several smaller streams. Although this area is properly called the Annapolis-Cornwallis Valley, the more common "Annapolis Valley" is used in this paper for the sake of simplicity.

The edges of the valley are distinctively marked by two escarpments known as North Mountain and South Mountain, which rise to more than 700 feet above sea level. Its floor is, on the whole, a gently undulating surface that slopes gradually upward to the highland borders on each side. The lower slopes of its walls have been completely masked with glacial till. Its middle and lowest levels are occupied by flat sand plains containing mud flats adjacent to the watercourses. At the west end of the valley Pereau and Habitant creeks and the Canard and Cornwallis rivers are separated by three sandstone ridges whose undulating surfaces rise about 100 feet above the surrounding valley floor (Cornwall, 1957).

A little more than half the soils of the Annapolis Valley have been developed on glacial till. These glacial soils, which lie mainly on the lower slopes of the valley sides, are the best for both orcharding and mixed farming. The other residual and water-transported soils, on the lowest part of the valley floor, are generally too light in texture for orchard use and are also less suitable for mixed farm crops. The lightest-textured of these soils are used primarily for special crops such as potatoes and other vegetables.

The well-drained loams are considered the best of the glacial-till soils for apple orchards: the clays are too poorly drained and the sands too droughty. Fortunately, most of the good orchard soils are on slopes that afford sufficient air drainage to protect the fruit crops from frost damage.

The *Soil Survey of the Annapolis Valley Fruit Growing Area* (Harlow and Whiteside, 1943) classifies more than 100,000 acres as suitable for apple-growing, but A. D. Crowe, horticulturist at the Kentville agricultural research station, considers that about one fifth of these soils are marginal for this purpose under prevailing economic conditions. This leaves the Annapolis Valley with more than 80,000 acres of excellent orchard soil. Since commercial orchard plantings at present occupy less than 13,000 acres, the valley industry can obviously expand sixfold even if orchards are limited to the very best soils.

More than 10,000 acres of the orchard lands are found in Kings County, at the east end of the valley (Figure 2). This concentration is most likely due to the east-end land type, which provides a greater number of extensive orchard sites with favorable slope and soil conditions. In the early days, road and rail proximity to the Port of Halifax may also have helped to encourage apple production.

In Kings County, the highest orchard density is on the glacial-till soils along the lower slopes of North Mountain. Other such areas occur on the slopes of the sandstone ridges adjacent to Minas Basin and on the divide between the Annapolis and Cornwallis rivers. In large areas of the valley there are only unkempt farmstead orchards or none at all.

The casual observer who drives along the country roads of Kings County may gain an exaggerated impression of orchard density. The reason is that the original orchards were all planted adjacent to the farmsteads, which were near the roads, and it is mainly these orchards that have since been expanded into commercial-sized units.

Because of its geographical location and land characteristics, the Annapolis Valley is climatically well-adapted for apple cultivation. The Bay of Fundy and Minas Basin moderate the cold continental winds from the north and northwest while North Mountain wards off northerly winds and the valley slopes give protection against radiation frost. The moderating effects of the Gulf Stream and the Atlantic Ocean are introduced by winds that enter the valley from the south and southwest.

Thus, for the latitude, Annapolis Valley winters are very mild. The −24°F experienced at Kentville

in 1920 is the lowest temperature recorded there in the 45 years preceding 1962. At Kentville, winter temperatures have dropped to −20°F or lower only three times in 30 years, and at Annapolis Royal they have never done so. During the same 30-year period, winter temperatures have dropped to −12°F or lower 12 times at Kentville and once at Annapolis Royal. Since −12° and −20°F are respectively the critical temperatures for dormant buds and peach-tree wood (Mercier and Chapman, 1955–56), it seems that the winters are moderate enough for all the fruits grown in the Annapolis except peaches and cherries, which are more susceptible to winter injury. At the west end of the valley the winters are mild enough for peaches, but at the east end there is a chance that low winter temperatures will cause a peach-crop loss about every second year. Almost every winter, in fact, new growth on peach and cherry trees is injured to some extent. The life span of peach and cherry trees is very short: about 50 per cent of them die before they reach maturity.

An advantage of the winter climate of the Annapolis Valley is that the fall-to-winter temperature change is gradual. Thus the fruit trees have a chance to harden up in preparation for the cold season, and winter damage to apple orchards is consequently a minor problem.

The average frost-free period ranges from 127 days at Kentville to 139 days at Annapolis Royal. The shortness of the frost-free period and growing season and the insufficiency of summer heat (the mean summer temperature is only 62°F) are the valley's major climatic disadvantages for fruit-growing. Apple varieties such as the Winesap and the Yellow Newtown, which are grown in the Okanagan Valley, will not mature in the Annapolis; and in cool years the size attained even by such varieties as the Red and the Golden Delicious are barely acceptable.

The first fall frost usually occurs around the end of September, and by the last two weeks of October temperatures are commonly as low as 20°F. A temperature of 23°F will injure apples left on the trees, and growers who, in an effort to gain size, leave their apple-harvesting until late in October run the risk of frost damage in three years out of 10.

Spring frosts do not generally result in much apple-crop damage because the cooling effect of the surrounding water delays blossoming until the danger is past.

The Annapolis Valley has as good a frost record as any other important apple-producing region in North America.

The amount of sunshine, however, is inadequate for optimum growth and the coloring of fruit. Its average of 835 hours for the period from June to September inclusive is about the same as that of the Quebec orchard areas but more than 100 hours less than the averages of southern Ontario and the Okanagan Valley.

The Annapolis Valley also has a considerable amount of cloud, fog and rain during apple-blossom time. Since the apple is not only insect-pollinated but also cross-pollinated, cold wet weather during bloom time results in a poor set of fruit. A number of growers rent hives for this period to increase bee activity in their orchards to the highest possible degree.

The valley rainfall, which totals about 40 inches, is distributed fairly evenly throughout the year and is sufficient for orcharding. It is likely, however, that the lack of moisture during the midsummer drought periods would increase the apple crop. Some growers water their orchards during dry spells, but irrigation is generally haphazard. As there has been little experimentation with it, growers do not know how much or how often to irrigate. Because investigation has been lacking, it is not known whether water applied in the right amounts would increase the yield enough to make irrigation economically feasible.

High humidity in the growing season generally results in disease problems. In apples, scab is a constant threat; in plums black rot is rampant. Fungus diseases attack the cherries, and rain splits them if it comes when they are almost ready for harvest.

Although the Annapolis Valley lies in a hurricane zone, severe hurricanes are not frequent. When they come, however, the damage to fruit crops is very great. In 1955, for example, Hurricane Edna caused the loss of between 30 and 40 per cent of the apple crop.

ORCHARD TRENDS AND ECONOMIC CONDITIONS

The first apple trees in Nova Scotia were planted by the French settlers of the early seventeenth century. Apple-growing received its real impetus, however, with the immigration of the pre-Loyalists after 1755, the year of the expulsion of the Acadians. These settlers from New England

introduced both New England and British varieties and even developed varieties of their own.

Until the middle of the nineteenth century, apples were produced primarily for the farm family's own consumption and for the sake of a few sales to local merchants. It was difficult to sell extensively to the larger markets of Saint John, Halifax and New England because the fruit, carelessly harvested and badly packed, was in poor condition when it reached its destination.

Annapolis County took the lead in the apple industry until about 1859, largely owing to its easier access to markets. The Annapolis River and the Bay of Fundy provided it with convenient and cheap transportation to Saint John. The completion in 1856 of the railway from Windsor to Halifax gave the east end of the valley also a convenient means of transporting apples to Halifax. From that time on, the apple industry of Kings and Hants counties expanded rapidly.

Successful penetration of the British market in the latter half of the nineteenth century started a period of explosive growth. The first financially successful shipments were made to London in the 1860's, and by the early 1890's the Annapolis Valley was exporting to the same destination more than 100,000 barrels of apples annually.

For several decades, the orchard industry could sell as many apples as it could produce, and the Annapolis output increased from 226,000 bushels in 1871 to 1,371,000 bushels in 1900.

Thus, before the turn of the century, Nova Scotia began to ignore the local market, which was easily oversupplied, turned away from the New England market to avoid the increased competition prevailing there and the United States duty, and focussed its attention on the British market. This meant concentrating on the production of late-keeping, hard-textured, winter varieties capable of withstanding long-distance transportation in barrels. Since any kind of hard apple could be sold, growers produced a multiplicity of varieties. By 1900 some 200 kinds of apple were being grown commercially in the Annapolis Valley, 50 of the main varieties making up the bulk of the crop.

The Annapolis orchard industry was adversely affected by World War I. After the war, Annapolis growers had to meet keen competition from the United States and British Columbia, both of which were exporting apples of higher quality packed in boxes instead of barrels. As a change-over to higher quality in a superior pack would have required a great deal of investment and time, the Annapolis Valley growers decided to retain the barrel to which apple varieties, storage facilities and handling methods had been adapted and to emphasize economy in production and distribution instead of trying to maintain their competitive export position by altering the product. Because of their geographical location, they were able to ship more cheaply to the United Kingdom than their principal competitors.

By 1929, the combination of a shrinking British market, an expanding orchard industry and depressed prices led to economic distress in the Annapolis Valley. For the first time, there was concern about the possibility of overproduction. A royal commission investigated the apple industry and suggested a co-operative company to control the sale of the whole apple crop and thus eliminate the price-depressing competition prevailing among individual shippers. The industry rejected the suggestion.

The depression of the early 1930's led to the Imperial Economic Conference, held in Ottawa in 1932, which gave the preference to Empire apples in the markets of the United Kingdom. Exports from the United States consequently declined, and Nova Scotia became the United Kingdom's main supplier of apples. Then British production increased, and in 1937 the tariff preference for Commonwealth apples was reduced. Thus, in the late 1930's, Nova Scotia's position in the British market weakened.

When World War II broke out, restrictions were placed upon Canadian apple exports. Because the domestic markets could not absorb the Annapolis output, the federal government subsidized the manufacture of apple products, and the provincial government established the Nova Scotia Apple Marketing Board Limited to act as a central selling agency and to administer the government assistance program. The Board stabilized the industry by reducing excessive competition among shippers. A number of growers and shippers, however, put up strong resistance, and in 1951, at the request of the Nova Scotia Fruit Growers' Association, the provincial government suspended the Board's powers. The apple industry then reverted to the uncertainties associated with free selling (Morse, 1952).

During and after World War II, the Annapolis orchard industry came to the realization that it could no longer exist unless it adapted its product to the demand. Not only was it losing the United

Kingdom market to competitors, but United States and British Columbia apples were being sold right in the Maritimes. It was essential to turn to the production of dessert apples, pack in boxes and construct cold-storage facilities.

Federal and provincial subsidies were paid to assist growers to pull up trees of unwanted varieties. For each tree cut $2 was paid, and the removal of the stump and brush brought an additional $2. Bonuses were paid to growers who grafted old trees into new varieties.

In the 20 years from 1939 to 1959, the reduction amounted to more than a million trees, or 50,000 a year. Tree removal was more intensive in the early 50's, but by 1959 it had tapered off to 25,000 a year. In the early years of the 1960's, new plantings have just been keeping pace with removals, and the number of trees seems to have become stable at 600,000, which annually yield 3 million bushels. The trees reached their peak in numbers (7,500,000) in 1911 and in production (8,288,000 bushels) in 1933.

In the early 50's, Britain started to buy Canadian apples again but took only the British Columbia product, with its superior packaging, quality and appearance. By the middle of the decade, however, having adopted box packing and refrigerated storage and changed to dessert varieties such as Red Delicious and McIntosh, Nova Scotia was again making gains in the British market. Apple sales to the United Kingdom increased from the 1945–54 annual average of 50,000 bushels to one of 200,000 bushels for 1955-59. By 1961, the annual sale of Annapolis apples to the United Kingdom had climbed to 400,000 bushels, or more than 60 per cent of the apples exported and more than one third of the fresh apples sold. In 1961–62, an additional 200,000 bushels went to European countries other than the United Kingdom. Europe thus provides about half the market for the Annapolis fresh-apples sold.

In recent years, Nova Scotia has supplied the Atlantic Provinces with 200,000 bushels of apples annually. Smaller amounts have gone to Ontario and Quebec, the volume of sales depending a great deal upon the size of the apple crops in those provinces. In the last decade no Annapolis apples have found their way west of Ontario, and very few have been sold in the United States (Canada Department of Agriculture, 1954–62 and 1961–62).

The Annapolis Valley has never produced soft fruits in significant quantities. The output of its 12,800 acres of commercial orchard is at present 93 per cent apples, 5 per cent pears and 2 per cent peaches, cherries and plums. Winter injury and an insufficiency of summer heat have discouraged the production of peaches and sweet cherries. Pears and plums have never been an important product of the valley industry because, although the climate is quite suitable for them, they lack a market.

After the war years, the valley apple industry continued to process a large part of the crop. In 1961 it processed about 60 per cent—25 per per cent into canned and frozen apple slices, applesauce and pie-fill and 35 per cent, of lower quality, into apple juice, concentrate, vinegar, fermented apple product and dehydrated apples. Thus it is apparent that culinary apples are still the mainstay of the industry. Some growers, in fact, are again planting cooking varieties.

As a result of the removal of small orchards and the planting of most of the new ones by growers whose orchards are already large, the average size in the Annapolis Valley is constantly increasing. According to the 1961 *Census of Canada*, which covers all orchards with 25 or more trees, the average for Nova Scotia is 9.6 acres. Most of the orchards of 1, 2 or 3 acres are either improperly cared for or abandoned and so cannot be regarded as in commercial operation. The results of a questionnaire sent to commercial orchardists in the Annapolis Valley in 1959 shows that 41 per cent have from 1 to 10 acres of orchard, 42 per cent from 11 to 30 acres, 13 per cent from 31 to 50 acres and 5 per cent more than 50 acres. The most successful orchardists and horticultural and marketing experts in the valley generally agree that 20 acres is the minimum for a full-time commercial operation.

For most of the Annapolis fruit growers, orcharding is only one of a number of farm activities, being usually part of a mixed-farming operation in which dairy cattle are the most common livestock specialty. The production of potatoes, other vegetables, poultry and eggs is becoming increasingly important in the valley and is often combined with apple-growing. Farm records kept by the marketing agencies show, however, that large orchards, when their operation is the sole farm activity, yield more per tree as well as fruit of better quality and a higher net income per acre. In addition, field observations and interviews indicate that farmers who specialize exclusively in orchards are the most prosperous. There is a gradual trend toward special-

ization in orcharding, but it has not yet gone nearly so far as in such other orchard regions as Ontario's Niagara Fruit Belt and British Columbia's Okanagan Valley. The reluctance to specialize in orchards may be due to a reluctance to depend upon one crop, which results from the marketing problems of the past.

An increase in orchard size accompanied by an improvement in varieties and cultural practices has resulted in a constant rise in apple yields. In 1945–50 the average annual yield per bearing tree was only 3 bushels; in 1956–60 it was 5 bushels. A survey conducted by the Nova Scotia Department of Agriculture in 1959 indicated that about 20 per cent of the apple acreage was getting only second-class care and that another 20 per cent was being neglected. Thus there should be a good chance to increase productivity still further. Agricultural officials and the more successful growers feel that the orchard industry would be much better off if it could eliminate the small inefficient operators.

In sympathy with the changing demand, the valley apple varieties have greatly changed over the last 20 years (Table 5). In 1939 the dessert apples McIntosh, Delicious and Cortland were insignificant, but in 1959 they made up 29 per cent of the tree total. Wagener, Gravenstein and Spy have shown small percentage increases, probably because they are the best of the old varieties for both eating and cooking. Ben Davis and Stark, top varieties in 1939, are rapidly diminishing in importance. About half the new plantings of all varieties are on semidwarf rootstocks.

Table 5

Apple varieties in the Annapolis Valley, 1939, 1949 and 1959

Variety	Percentage of tree total		
	1939	1949	1959
McIntosh	4	9	15
Delicious	3	7	14
Wagener	10	11	13
Gravenstein	8	8	11
Spy	6	7	8
Cortland	1	3	7
Ben Davis and Gano	13	11	6
Golden Russet	8	7	6
King	6	5	5
Stark	12	9	3
Other varieties	29	23	12

Sources: Census of Apple Orchards in Nova Scotia, 1939 and 1949, and *Sample Census of Apple Orchards in the Annapolis Valley*, 1959. (All three surveys were conducted by the Nova Scotia Department of Agriculture.)

The Annapolis Valley is the only orchard region in Canada that has a complete biological-chemical insect-control program. The spray program the valley orchardists have accepted under the guidance of A. D. Pickett, entomologist of the federal Department of Agriculture requires the use of chemicals that are not seriously detrimental to beneficial insects. When chemical control is necessary, selective insecticides are used instead of those that are known to kill many species. A survey of 80 orchards where the integrated spray program is in effect shows that the injury caused to apples by the codling moth has declined from the 1948 high of 30.8 per cent to a 1963 low of 1.5 per cent. The integrated biological-chemical insect-control program has not only proven effective but has brought substantial reductions in the costs of insecticides.

In the Annapolis Valley operations have always been cheaper per tree than in any other important orchard area of North America. The cost of land is very low; an integrated biological-chemical insect-control program has reduced the cost of spray; the cost of labor is below the Canadian average. Recent changes to more desirable varieties, expansion of orchard operations and its resulting efficiencies, a rapid rise in yield and quality, and modern storage and packing have enabled the growers once again to compete advantageously with those of other fruit-growing areas on Canadian and foreign markets.

The area's greatest disadvantage is its lack of a single co-operative selling agency. Scotian Gold Co-operative Limited, which succeeded the United Fruit Company in 1957, handles about half the apples produced, and most of the co-operative companies send it the growers' fruit for packing and cold storage. The quantities thus received are pooled and sorted by variety, grade and size. In 1930 the Royal Commission investigating the Apple Industry of the Province of Nova Scotia recommended the adoption of completely co-operative methods and highly centralized control, saying that these were the universal practice in other parts of the world where the same difficulties were encountered. It is an old problem in the Annapolis, however, that a considerable number of growers refuse to join co-operatives and insist on competing for markets individually. In view of this attitude, it is unlikely that Nova Scotia will adopt central selling unless forced to do so by market disasters.

If there is no drastic change in market conditions, the orchard acreage of the Annapolis Valley will probably remain stable for the next few years while the yield continues to edge upward.

THE ORCHARD INDUSTRY OF THE SAINT JOHN VALLEY, NEW BRUNSWICK

LOCATION, LAND TYPE AND CLIMATE

The orchards of New Brunswick lie almost entirely in the Saint John River valley. Their greatest concentration extends from about 10 miles west of Fredericton to Gagetown, about 30 miles downstream (Figure 3). In this area the width of the valley varies from about 1 mile just west of Fredericton to about 3 miles farther downstream. The surrounding highland rises some 200 feet above the valley floor.

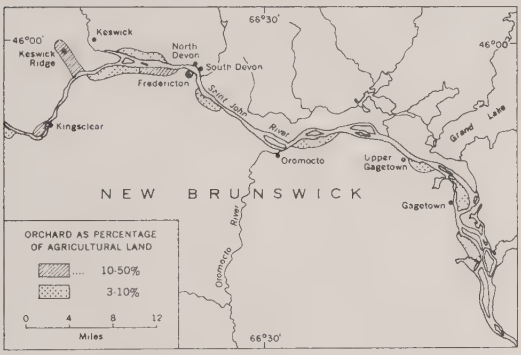


FIGURE 3. The orchard region, Saint John Valley, New Brunswick.

During the retreat of the glaciers, the glacial till that covers the valley slopes was buried under layers of sand and fine gravel varying in depth from 1 to 10 feet.

Most of the orchards have been planted on these sandy and gravelly loams where the clayey till is not less than 2 feet but not more than 5 feet from the surface. Such soils provide good drainage yet are not too dry, and are good for root development (Stobbe, 1940).

The climate of Fredericton, N.B., is similar to that of Kentville, N.S.: the frost-free season totals 140 days; precipitation amounts to 40 inches annually; the mean summer temperature is 64°F. In the Saint John Valley, however, the winters are much more severe. Every winter in 1950–59, the temperature at Fredericton fell below −12°F; in five years of that decade it went below −20°F; on one occasion it plunged to −32°F. Because of the severity of the winters, no fruits other than apples are produced commercially, and even of these only the hardiest varieties can survive.

ORCHARD TRENDS AND ECONOMIC CONDITIONS

New Brunswick farmers began the commercial production of apples in quantity in the years following the 1917–18 freeze, which seriously damaged orchards and reduced the apple crop in Ontario and Quebec. Because their orchards had escaped winter damage, the New Brunswick orchardists felt that they had a good opportunity of capturing the Ontario and Quebec markets. Orchards were planted in the Saint John Valley upstream as far as 25 miles north of Woodstock and downstream to the river mouth. Others were planted around Oak Bay, along the south shore of the Petitcodiac River near Moncton, and even along the shore of Northumberland Strait in the vicinity of Shediac. By 1921, there were almost 8,000 acres.

During the 1930's the rate of orchard increase levelled off, but since 1940 the apple acreage has been gradually rising. The annual planting-rate average, which in the 1940's was 150 acres, decreased to 75 acres for the 1950's.

According to the most recent provincial orchard census New Brunswick now has 2,500 acres of apple orchard. This includes orchards of all sizes, many of which are not commercially productive. A realistic estimate of the commercial total is closer to 2,000 acres. Of the 318 growers, only half are giving their orchards first-class care (New Brunswick Department of Agriculture, 1959).

The average orchard size is only 8 acres. Thus there is a large number of very small orchards. Only a few growers have orchards of more than 20 acres.

The average farm size in the main orchard area is about 200 acres, of which less than half is usually cropland. The farms are laid out in long narrow strips about 200 to 400 yards wide that run several miles back from the river. Only the front end is cultivated, the back remaining in forest. Most orchards are part of mixed-farming operations in which oats, hay and pasture occupy by far, the largest part of the cultivated land.

Many farmers combine orcharding and mixed farming with lumbering, which is the source of substantial revenue during winter and spring. Lumbering sometimes interferes, however, with the proper care of orchards, because the farmers are busy in the forest at times when they should be carrying out orchard activities such as pruning the apple trees.

Apple production has risen steadily from a running annual average of 100,000 bushels for the five-year period ending with 1930 to one of 400,000 bushels for the five-year period ending with 1960. The peak was reached in 1961, when the province produced 525,000 bushels (New Brunswick Department of Agriculture, 1950–62).

The McIntosh apple is by far the most popular variety, accounting for 46 per cent of the number of trees. It is followed by the Cortland, which makes up 18 per cent. Next in order of importance come the Lobo, Melba and Red Delicious, these three combined accounting for less than 10 per cent. The Delicious apple might be grown more extensively if it could withstand winter temperatures (New Brunswick Department of Agriculture, 1959).

From 1920 to 1940, about half of New Brunswick's apples went to the Province of Quebec, but since 1940 the output has been marketed primarily at home. In the 1940's, sales within New Brunswick ranged from 71 per cent to 87 per cent of production. In the 1950's, they increased to more than 90 per cent. The apples shipped out go primarily to Quebec, the other Atlantic Provinces and the United Kingdom.

The province also imports apples. In the early 1960's it has received between 60,000 and 80,000 bushels a year, mostly from British Columbia, Quebec, Nova Scotia and the United States. Almost all the apples imported, except those from Quebec, are of varieties not grown extensively in New Brunswick (New Brunswick Department of Agriculture, 1950–62).

Because it does not suffer from the vagaries of an export market, the New Brunswick orchard industry has enjoyed great stability, and growers have received higher prices per bushel than their counterparts in Nova Scotia. The New Brunswick Apple Exchange Limited, organized in 1930, has done much to standardize packing and quality and to stabilize prices even though it handles only about 35 per cent of the crop.

If the New Brunswick orchard industry continues to saturate the domestic market, it is likely to maintain its present size and level of prosperity.

THE ORCHARD INDUSTRY OF QUEBEC

LOCATION, LAND TYPE AND CLIMATE

Apple orchards are found throughout the southern part of Quebec from the Ontario border to a point some 60 miles northeast of Quebec City. About 95 per cent of the commercial orchards lie in the southwest corner of the province within 50 miles of Montreal (Figure 4). Small orchards are scattered across most of the counties south of the St. Lawrence River from the Monteregian Hills region to a line drawn south from Île aux Coudres. The only orchards of commercial significance east of the Monteregian Hills are on Île d'Orléans and on the part of the north shore of the St. Lawrence River that lies just opposite and is known as the Beaupré Coast.

All the important commercial orchard regions are on land that slopes considerably and contains well-drained light-textured soil. The physiography and soils are described in more detail under the regional headings.

The climate of the principal orchard regions of Quebec is similar to that of the Saint John Valley of New Brunswick but is more continental. The greater summer heat gives an advantage over both the Saint John and the Annapolis valleys. Climatic statistics for Montreal show an annual average precipitation of 41 inches, a mean summer temperature of 67°F and an annual sunshine average of more than 1,800 hours, half of which are in the four months from May to August. The frost-free period in the southwest ranges from 120 to 140 days, depending upon the slope and direction of exposure of the meteorological station. All in all, the climate favors apple orchards.

Tree injury resulting from low winter temperatures is the greatest hazard facing Quebec orchardists. In winter, the thermometer frequently plunges to −25°F or lower. The lowest recorded temperatures in the chief orchard regions range from −35°F to −40°F. In the Île d'Orléans orchard region the winters are even colder. For Quebec City (just west of Ile d'Orleans) the mean January temperature is 10°F, whereas for Montreal it is 13°F. The mean summer temperature of Quebec City is also about seven degrees lower than that of Montreal.

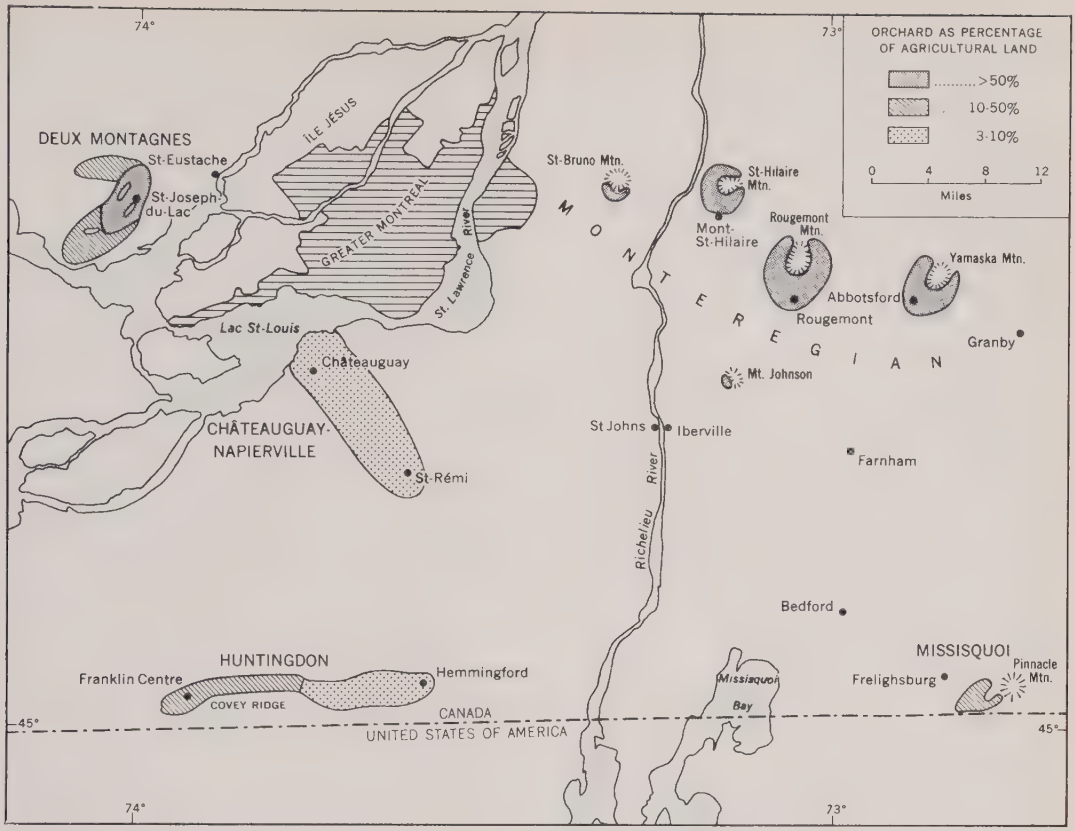


FIGURE 4. The orchard regions of Quebec.

The cold winters have caused the province serious orchard losses. Thus in 1917–18, Quebec lost about half its bearing trees. In 1933–34 temperatures dropped to between −30°F and −35°F in all the principal orchard regions and killed 47,000 trees, or about 8 per cent of the total, and many more trees were severely damaged. The crop, which in 1933 amounted to 320,000 barrels fell in 1934 to 90,000 barrels (Sinclair, 1934).

After 1917–18 the Spy and Ben Davis varieties, which had been hard hit, were replaced with the hardier McIntosh. In 1933–34, consequently, tree losses were smaller although large numbers of the Fameuse were killed. These, in turn, were replaced with hardier trees. Since 1934, despite temperatures below −30°F, frost fatalities have been fewer because of the predominance of the hardier varieties. In extremely cold winters, however, there has been considerable tree damage and crop reduction.

ORCHARD TRENDS AND ECONOMIC CONDITIONS

In the nineteenth century, farmstead apple orchards were common throughout much of southern Quebec. As the population increased, particularly in the Montreal area, farmers with favorable orchard sites began to grow apples on a commercial scale to supply the demand of the growing cities. The most rapid orchard development occurred closest to Montreal, in the Deux Montagnes and Monteregian Hills regions.

By the early 1930's Quebec had 11,000 acres of orchard and was annually producing about 1,300,000 bushels of apples for the provincial market. Large quantities were still being imported from Nova Scotia, along with smaller quantities from New Brunswick, Ontario and British Columbia.

The freeze of 1933–34 resulted in a decline in orchard acreage in the decade of 1930–40, but in the 1940's, with good prices and the discovery that apple growing was the most profitable of all

farm enterprises, farmers planted large acreages. Because of their proximity to the market, local growers could sell profitably in Montreal at prices that competitors in other provinces could not meet.

By 1951, Quebec had 30,000 acres of orchards, or three times as many as 20 years previously. By the early 1950's, the provincial market had been saturated, orchard profits had begun to drop, and growers had started to neglect marginal orchards. The 1961 *Census of Canada* shows only 26,000 acres, and field observations and interviews indicate that the trend toward the removal of apple orchards in areas of unfavorable climate or poor soil is continuing.

The *Census of Canada* tabulates all orchards of more than 25 trees and so includes many that are not commercial. The main apple-growing regions total only 19,000 acres of orchard (Table 6).

Lack of profits has forced inefficient growers out of business, and the orchardists who remain are expanding their operations to cut the per unit cost of production. In 1956 Quebec orchards of more than 20 acres made up about 32 per cent of the total, those of 10 to 20 acres 29 per cent, and those of less than 10 acres 39 per cent.

Many apple growers still run mixed farms, often with a dairy specialty, but the trend is toward orchard specialization, particularly in the Monteregian Hills region.

Because growers are fewer and orchards larger, yields are increasingly higher. The provincial average per bearing tree in 1956 was 3.4 bushels. Only in Missisquoi County, which yields 5.2 bushels per bearing tree, does the apple harvest compare favorably with that of the Annapolis Valley.

Owing to its hardiness and high quality, the McIntosh is by far the most popular variety, making up 65 per cent of all the apple trees in the province. Fameuse comes next with 11 per cent, Melba with 5 per cent, and Cortland, Duchess, and Lobo with 4 per cent each.

In the early days of the Quebec apple industry, the Fameuse (better known as the Snow apple in English-speaking Canada) was the most important variety. It is generally considered excellent for desserts and imparts a delicious and unique flavor to processed products. Unfortunately it lacks hardiness and is low in yield and susceptible to scab infection. Since the heavy losses of Fameuse apple trees in the winters of 1917–18 and 1933–34, new plantings of this variety have been very light. A recent study made by the Quebec Agricultural Marketing Board recommends that the Fameuse apple be retained as an important Quebec orchard product (Arengo-Jones, no date).

In recent years, some orchardists have been planting a few Delicious trees to cash in on the high demand for that variety of apple, and there are now about 200 acres of them. Because of its lack of hardiness, however, the Delicious apple is not likely to become important in Quebec.

The annual output, amounting to more than 3 million bushels, is disposed of primarily within the province. About 80 per cent is sold as fresh fruit, and 12 per cent is processed. The balance is not sold, either because the apples are unfit for sale or because there is no market. About a quarter of the apple production is handled by co-operatives. The Monteregian Co-operative, the largest and most progressive in the province, has found a new outlet for lower-quality apples by developing a champagne-type cider, 200,000 gallons of which are produced annually.

Until recently, Quebec was unable to find any important export markets for apples. Since 1959, however, between 75,000 and 100,000 bushels have been sent annually to the United Kingdom. In some years considerable amounts of apple pulp and concentrates are sold in Europe. Quebec still receives many apples from outside its borders, particularly varieties such as the Delicious, which it does not grow extensively. Montreal, for example, receives between 300 and 500 carlots of apples a year from the United States and British Columbia (Canada Department of Agriculture, 1954–62).

Quebec's annual apple production fluctuates greatly, thus causing grave marketing problems in the boom years. In 1955, for instance, the provincial output was almost double the average for the previous ten years, with the result that prices were less than a quarter of the average for the same decade.

Since processed products absorb only a little more than one-tenth of the Quebec apple crop (mainly the fruit of poorer quality) the processing industry cannot help stabilize the fresh-apple market as it does in other provinces. A recent marketing study of the Quebec apple industry recommends a central co-operative plant to process a larger proportion of the average apple crop and—more important—to process large volumes of unsalable apples in bumper-crop years (Office des marchés agricoles du Québec, 1961).

In the future, the main problem of the Quebec orchard industry will be overproduction and marketing. In the face of stiff competition, it is unlikely that the province will be able to capture substantial markets in Europe, the United States or other parts of Canada. This means that most of the apple production must be marketed within Quebec. If the consumption rate and imports remain relatively constant, the future increase in the demand will depend upon the increase in the population of the province. The marketing report of the Office des Marchés agricoles du Québec states that the present orchard acreage could easily provide the volume required to supply the demand of Quebec's predicted 1980 population because many of the province's orchards have not yet reached peak production and orchard management is constantly improving.

After reviewing all of the industry's problems, the provincial marketing committee recommended (1) that orchardists continue attempting to reduce their cost of production per unit, (2) that a provincial apple marketing board closely linked with a central processing co-operative be established, (3) that the provincial acts and regulations concerning the quality and packaging of the product be strictly enforced and (4) that the growers and retailers combine their efforts in an apple-promotion campaign (Office des Marchés Agricoles du Québec, 1961).

Even if all of the marketing committee's recommendations are carried out, it would probably be unwise for the Quebec orchard industry to expand substantially within the next decade, unless some new large market is found.

The main orchard regions of Quebec, as delimited in Figure 4, are described briefly in the following section. These regions are combinations of the 15 delimited in the Quebec orchard census (Department of Agriculture, Province of Quebec, 1958). The description of land type is based upon the orchard-soils survey of Quebec (Stobbe and McKibbin, 1937) and field observations.

REGIONS

Deux Montagnes

The Deux Montagnes orchard region lies west of Montreal within Deux Montagnes County. Intensive orcharding is practised on all the suitable soils on all sides of both Deux Montagnes and the prominent glacial moraines in the region. The upper slopes of the mountains, too rough and rocky for cultivation, are covered with mixed forest.

The soils of the level plains surrounding the hills and mountains are poorly drained heavy clays suitable for hay and grain crops but not for orchards. The soils of the lower slopes are highly calcareous and have been classified as Calciferous moraine loam. This loam constitutes a productive soil suitable for almost all farm crops, including orchard products, and of a depth and friability that facilitate drainage and the free penetration of tree roots. By far the largest percentage of orchards is found on the well-drained phases of this soil type. The ill-drained phases, lying at a lower elevation, are less suitable for orcharding.

The Deux Montagnes region is one of the better orchard areas of Quebec. Its 1956 yield of 4.8 bushels per bearing tree was the second highest in the province. The farmsteads in the orchard districts are well kept and give an impression of prosperity. The 1961 orchard area, which exceeded 2,700 acres, was more than double what it was in 1934.

Monteregian Hills

Around the Monteregian Hills is the most important orchard area in Quebec, the area that annually produces more than one third of the provincial apple crop. It lies immediately east of Montreal on a plain consisting of glacial drift redistributed by the Champlain Sea, which covered the area in the latter stages of glaciation. The uniform expanse of the plain is broken by several isolated mountains composed of volcanic rock and varying from 200 to 800 feet in height. Three of these—St. Hilaire, Rougement and Yamaska—mark very important orchard districts. Saint Bruno Mountain and Mount Johnson are smaller, and the adjacent land suitable for orcharding is less extensive.

In physiography and soils, these hills are very similar. Their upper parts are composed of igneous rock either unvegetated or forest-covered. Between 150 and 400 feet above the plain, their slopes are mantled with gravel that has been deposited by the postglacial Champlain Sea and is called the Champlain Terrace. The terrace varies greatly in width. It is always most pronounced and broadest on the south and west sides, sometimes reaching a mile in width. On the northern and eastern sides it becomes very narrow and is sometimes absent altogether. The main type of soil found in the band of gravel around each hill is the Champlain Terrace gravel.

Farther down the slope, the sand in the gravel loam gradually increases until at the bottom there is a sandy loam. This blends into the poorly drained clays of the flat lowland.

Most of the orchards are on the Champlain Terrace gravel. This, because of its depth of gravel, porosity, drainage, deep penetration by organic matter, and well-balanced chemical composition, is excellent for apple-growing. Most of it was planted with orchards as early as 1934. Much of the sandy soil on the lower slopes, although less suitable, has also been planted with apple trees. The few trees planted through the years on the lowland clays give poorer fruit and are short-lived. Because of poor soil drainage and lack of air drainage, they are also susceptible to winter injury.

The Monteregian Hills have long been Quebec's main productive orchard region. In 1934 it contained 6,000 acres of apple trees, or more than half of the commercial orchards in the province. By 1961, it had more than 7,000 acres. In the last decade, however, almost 1,000 acres of orchard have been removed for suburban housing development. The trend is most obvious on the western slopes of St. Hilaire Mountain.

In the Monteregian Hills many of the growers specialize in orchards exclusively. More than half the orchards exceed 20 acres, and more than 30 per cent exceed 30 acres. The 1956 yield of 3.3 bushels per bearing tree was surprisingly low and was, in fact, slightly under the provincial average.

Many orchardists sell a considerable quantity of apples, apple products and vegetables, in addition to miscellaneous souvenirs at roadside stands, where Montrealers and other tourists are willing to pay good prices.

Missisquoi

The Missisquoi region, about 50 miles southeast of Montreal and very close to the United States border, lies within the front range of the Appalachian Mountains. The elevation of the orchard area, ranging from 350 to 800 feet above sea level, is much higher than that of the previously described regions. The topography is hilly and broken, deep valleys alternating with sharply rising hills. Pinnacle Mountain, which rises more than 2,000 feet, lies adjacent to the eastern limit of the orchard area.

Table 6

Quebec orchard statistics, by region

Region	Orchard acreage[1]		Total apple production	Average yield per tree	Percentage of orchards, 1956		
	1934	1961	(bushels, 1956)		Under 10 acres	10–20 acres	Over 20 acres
Deux Montagnes	1,029	2,710	554,494	4.8	31	29	40
Monteregian	5,988	7,119	1,170,694	3.3	21	26	53
Missisquoi	999	3,425	557,368	5.2	26	24	50
Huntingdon	765	3,774	307,987	2.8	39	31	30
Chateauguay—Napierville	2,270	1,199	291,151	3.0	47	32	21
Northern section[2]	—	998	372,203	2.3	57	29	14
Total	11,051	19,225	3,253,897	3.4	39	29	32

[1]To exclude all but the main commercial orchard areas, the counties from which the 1961 acreages are taken are restricted to those that have at least 200 acres of orchard. The 1934 acreages are for the same counties and are therefore directly comparable.

[2]The northern section includes all counties north and east of the Monteregian Hills. Because of the organization of the 1956 production and yield statistics for the Quebec orchard census, the northern section includes Shefford County (the area just east of Granby) and the Chateauguay-Napierville region includes Iberville County (with Mount Johnson). For the 1934 and 1961 acreage statistics, Shefford and Iberville counties are included in the Monteregian Hills region, where they geographically belong. In 1961 Shefford County had 850 acres of orchard and Iberville 534 acres.

Sources: orchard acreages—*Quarante-et-unième Rapport annuel de la Société de Pomologie et de Culture Fruitière de la Province de Québec*, 1934, "Statistiques des Vergers"; *Census of Canada*, 1961, Agriculture, bulletin AA-4, Table 17; remaining statistics—*Recensement des Pommiers, Production et Vente de Pommes*, v. I and II, Department of Agriculture, Province of Quebec, 1958.

The soils of this orchard region are formed on glacial till composed of a mixture of igneous, metamorphic and sedimentary rock materials. Orchards are found primarily on the lower southwest slopes of Pinnacle Mountain, growing on a gravelly loam underlain by a compact clay layer at a depth of about 3 feet. The shallower phases of the soil require undertiling for the draining off of surplus water during the wet season.

Missisquoi became a major orchard region much more recently than the ones previously described. In 1934 it had only 1,000 acres of orchard, but by 1961 these had increased to 3,400 acres. Half the orchards exceed 20 acres, and field observations indicate that growers are constantly increasing the size of these orchards with new planting. A few apple growers have become orchard specialists, but most of them combine orcharding with dairy farming. The 1956 yield of 5.2 bushels per bearing tree was the highest in the province.

Huntingdon

The Huntingdon region, about 50 miles west of Missisquoi, is also adjacent to the United States boundary. It consists of a strip of land about 20 miles long and 3 miles wide along the north-facing slope of Covey Ridge. On the basis of topography and soils and of orchard intensity, it can be divided into two district sections—the eastern section, or Hemmingford district, and the western section, of Franklin Centre district.

The Hemmingford district is the less important orchard area. The topography is composed of a number of north-south gently rising ridges separated by small valleys. There is much rough, rocky, uncultivable land covered with forest, scrub and unimproved pasture. Large numbers of rocks and boulders lie scattered on the ridges. Many rocks have been collected to build stone walls, which are a common sight.

The Calciferous moraine loam is the dominant soil in the Hemmingford district. It occurs only in narrow strips along the tops and upper slopes of the ridges and is not so deep or well drained as the soil of the same type found in the Deux Montagnes region. On the lower slopes a thin phase of it occurs with a compact clay layer lying at a shallow depth, and the result is poor spring drainage and summer drought. On the shallow phases undertiling is almost essential to successful apple growing but is very expensive because of the large number of rocks.

Because of the shortage of good soils, orcharding is not very intensive in the Hemmingford district. In the last 10 years, however, many small orchards have been planted, most of them on the upper slopes of the ridges, where the better soil is found. The orchards planted on the poorly drained soils of the lower slopes are smaller.

In the Franklin Centre district of the Huntingdon region orcharding is very intensive. Around the village of Franklin Centre, orchards are found primarily on a narrow strip of land at an elevation of from 400 to 500 feet that runs east and west along the north-facing slope of Covey Ridge. The predominant soil type of this strip is the Champlain Terrace gravel formed on beaches of the postglacial Champlain Sea. It is the same as the excellent orchard soil found in the Monteregian Hills.

Like the Missisquoi region, the Huntingdon has just recently increased in importance as an orchard area. The extent of its orchards, which in 1941 covered 1,800 acres had grown to 3,800 acres by 1961. The 1956 average yield per bearing tree was only 2.8 bushels, considerably less than the provincial average. The low yield is a reflection of the poorer soils of the Hemmingford district.

Chateauguay-Napierville

This region lies just 10 or 15 miles south of Montreal. The topography is generally flat with gently rolling glacial moraines, on which most of the orchards are planted. The better orchard soils are sandy clays and sandy loams. The soils of the flat land, which are very fertile, have been devoted to dairy farming and such canning crops as peas and tomatoes.

At one time the Chateauguay-Napierville region was an important orchard area. The land on which many of the orchards were planted was, however, too flat and poorly drained and consequently suffered greatly from winter temperatures. Since the severe winter of 1933–34, which killed one-third of the apple trees, orcharding has been declining. In 1934 the area devoted to it was 2,300 acres, but by 1961 this had contracted to 1,200 acres. Almost half the orchards are of less than 10 acres. It is likely that most of these small, poorly kept orchards will soon be abandoned. Anyone who drives through will fail to recognize this as an orchard area unless he happens to pass some of the few large orchards that remain.

96009—4½

Île d'Orléans

The Quebec orchard census groups all counties north and east of the Monteregian Hills into one section termed *zone nord*. The only important orchard area within this northern section of southern Quebec is Île d'Orléans, which gives its name to the region. Orchards are also found along the narrow strip of mainland known as the Beaupré Coast, which lies immediately north of Île d'Orléans, and on Île aux Coudres, some 32 miles to the northeast. The orchards scattered across the rest of the section are small.

The orchards of Île d'Orléans, which is some 20 miles long and about 5 miles wide at the centre, are concentrated along the north side. Operations are most intensive in the middle of this north-shore strip, where the terraces are broadest and the sandy and gravelly loams suitable for apple trees are most plentiful. The orchards, on the whole, are not very large, almost 60 per cent of them being of less than 20 acres. In the last five years new plantings have been few. Orcharding is usually combined with dairying; and potatoes and strawberries are important cash crops for the nearby Quebec City market.

On Île aux Coudres are the most northerly and easterly orchards in Quebec. The extent of the the island's orchards, which amounted to 237 acres in 1941, had declined by 1961 to 103 acres. The small farmstead and commercial orchards that remain help to supply the local market.

THE ORCHARD INDUSTRY OF ONTARIO

LOCATION, LAND TYPE AND CLIMATE

Orchards are found throughout the greater part of southwestern Ontario, along a narrow strip north of Lake Ontario and in the St. Lawrence and Ottawa valleys. Within this area, precipitation, length of growing season, summer heat and hours of sunshine are all adequate for apple growing. In most of the area winter temperatures never go below −30°F and temperatures of −20°F are rare. Only in a small part of the interior of southwestern Ontario and in the Ottawa and St. Lawrence valleys are winter temperatures a major hazard to apple orchards (Figure 5). The main orchard regions are adjacent to the shores of the Great Lakes (Figure 6), where winter temperatures are more moderate and the cooling effect of the water in spring delays blossoming until most risk of frost is past. All the orchard sites have some degree of slope, and the soils range from droughty sands to well-drained clay loams.

Apples, which account for 50 per cent of the orchard acreage, are grown over a wide area. Peaches, which occupy 24 per cent, are grown extensively in the Niagara Fruit Belt and Kent-Essex regions, the only ones with mild enough winters and enough of the right kind of soil. The less important fruits—cherries, pears and plums—are grown primarily in the Niagara Fruit Belt.

Because of its hardiness and popularity as a dessert fruit, the McIntosh is the most important apple variety in Ontario, the product of 36 per cent of all apple trees. Next comes the Spy (both Northern and Red), an excellent eating and cooking fruit that keeps well, the product of 21 per cent.

Red Delicious follows with 15 per cent. No other variety accounts for more than 5 per cent. The predominance of varieties differs considerably from region to region, the McIntosh being more important where the winters are colder.

Because of the great diversity of physical conditions affecting orchards in different parts of the province, land type and climate are discussed in detail in the regional subsections.

ORCHARD TRENDS AND ECONOMIC CONDITIONS

From the early pioneer days, the orchard was an important aspect of farming in much of southern Ontario. It provided fresh fruit for most of the winter and, as production increased, a cash crop. The farmstead orchard remained important until the early 1930's. In 1931, according to the *Census of Canada*, there were 53,000 farms in the province with orchards of more than 25 trees. Only 2,000 orchards exceeded 10 acres.

The trend away from small farmstead orchards began after the severe damage of the cold winter of 1917–18 and was accelerated when the freeze of 1933–34 killed many trees that had subsequently been planted and were just reaching peak production. In the mid 1930's, from the viewpoint of climate alone, the future of Ontario's orchard industry looked bleak in all but the mildest parts of the province. In addition, apple scab and maggots were an increasing menace. It became impossible to market apples unless the

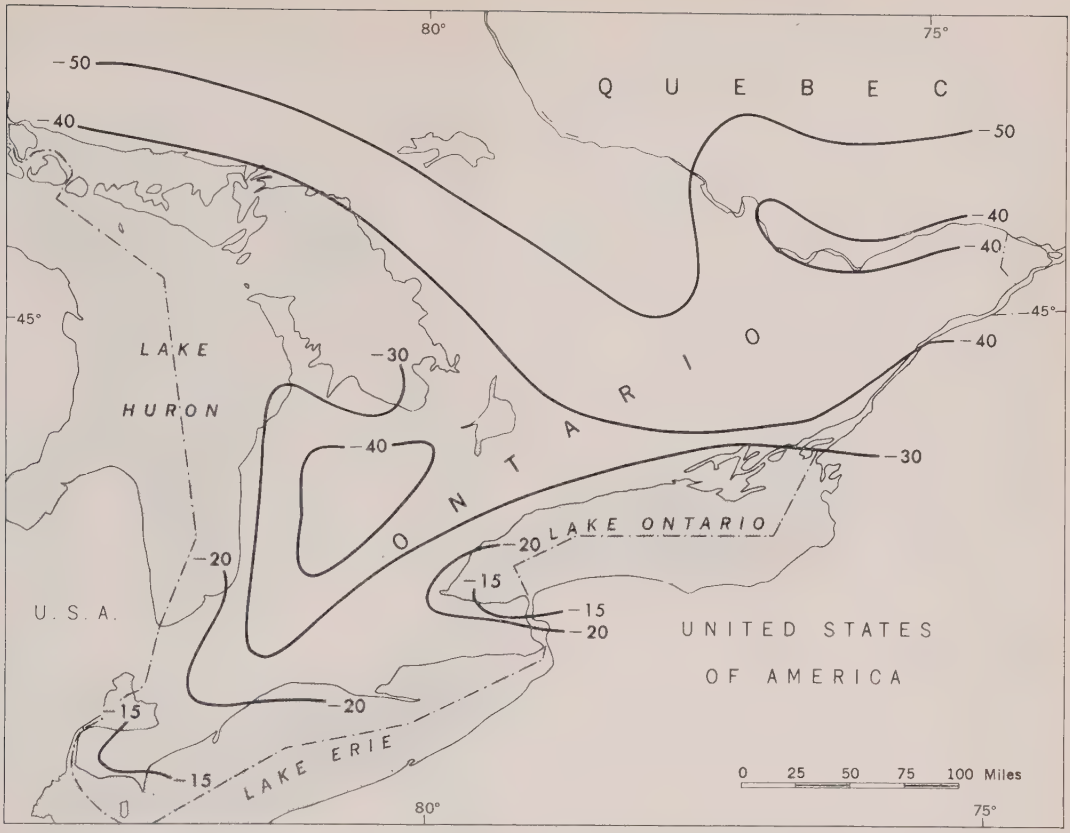


FIGURE 5. The lowest recorded temperatures (degrees Fahrenheit, 1924-54) in southern Ontario.

trees were sprayed, but spraying equipment was not economic for an orchard of 1 acre or less. Besides, the spraying had to be done in the spring, when the farmer was busy with seeding. Most farmstead orchards were consequently neglected. Some were uprooted, but most have remained as insect-ridden, disease-infected derelicts. Where the climate is less favorable, most of the trees have died and have been cut, leaving only stumps or a few scattered trees as a trace of past orchards. Where descendants of the Pennsylvania Dutch settlers predominate, apples from neglected orchards are still used to make apple butter for home consumption.

According to the *Census of Canada*, the orchard area amounted to 181,000 acres in 1921 but had declined by 1941 to 80,000 acres and by 1961 to 69,000. In 1931 the number of farms with 25 or more fruit trees totalled 53,000 but by 1961 had fallen to 8,000, only 6,000 of which had commercial orchards. In this 30-year period, on the other hand, the average orchard size increased from $2\frac{1}{2}$ to 10 acres. Thus, as farmstead orchards declined throughout most of the province, farmers in the areas of more favorable climate began to make orcharding their specialty.

With increasing specialization, yields have been constantly rising. In the early 1930's, the provincial apple average was less than 2 bushels per bearing tree. By 1961 it had increased to more than 5 bushels and thus compared favorably with the yields of other apple regions of eastern Canada.

The increase in yield has resulted in higher production despite lower acreage. The annual average apple production, which was 2.2 million bushels in 1927–31 and 2.5 million in 1945–50, increased to 4.6 million bushels in 1957-61.

The production of all other tree fruits has also been increasing and, with the exception of the cherry yield, has been coming from smaller acreages (Table 7). The increase in the cherry

Table 7

Acreage and production of tree-fruit crops in Ontario, 1945-61

Crop	Acreage		Average annual production	
	1945	1961	1945–50	1957–61
Apples	33,000	25,900	2.5 million bushels	4.6 million bushels
Peaches	15,500	12,000	55.0 million pounds	113.1 million pounds
Cherries	4,300	5,000	12.5 million bushels	25.5 million bushels
Pears	5,800	5,000	18.7 million bushels	37.2 million bushels
Plums and prunes	4,300	2,700	16.0 million bushels	17.7 million bushels

Source: Farm Economics and Statistics Branch, Ontario Department of Agriculture, Toronto.

acreage has resulted from large plantings of sweet cherries in the Niagara Fruit Belt. Pear trees occupied 5,800 acres in 1945 and 7,000 in 1951 but only 5,000 in 1961. The peach yield has risen notably, having doubled despite a loss of more than 3,000 acres that has occurred since 1945.

In the early 1930's Ontario exported between 30 and 40 per cent of its apple production. Some of this went to Quebec, but the largest part went to the United Kingdom. During World War I, because of a lack of shipping, the latter market was lost to Ontario apple growers; and immediately after the war it was drastically reduced by currency restrictions and strict quotas. By the time Britain was again able to buy large quantities of Canadian apples, Ontario was unable to compete successfully with Nova Scotia prices and British Columbia varieties, packaging and selling methods. When Quebec began to supply most of its own demand for apples, Ontario was restricted primarily to its own domestic market.

Today, the bulk of Ontario's fruit production is consumed within the province. Apart from large shipments of soft fruits to Quebec, the only significant tree-fruit exports are the apples shipped in some years, to the United States and the United Kingdom. Between 1958 and 1962, annual apple sales to the United States fluctuated from a low of 16,000 bushels to a high of 142,000 bushels. In the same period annual apple exports to the United Kingdom have ranged from 4,000 to 100,000 bushels.

Relatively small quantities of apples are shipped into Ontario, primarily from British Columbia. In recent years these shipments have amounted to less than 500,000 bushels a year.

In the last few years, between 30 and 50 per cent of Ontario's apples have gone into processed products, and the volume so used has been much higher in bumper-crop years. Apple juice is the most important processed product, accounting each year for about half the apples processed. The Ontario apples not processed are sold as fresh fruit. Controlled-atmosphere cold storage has made it possible to make such sales as late as July, thereby considerably extending the fresh-apple market season.

With the other tree fruits, processing is also important. In 1959, which was an average year, the fruit crops were processed in the following proportions: plums and prunes, 25 per cent; peaches, 56 per cent; cherries, 64 per cent; and pears, 94 per cent.

Marketing is the greatest single problem facing Ontario orchardists. The Ontario Food Terminal in Toronto provides a central market where growers can dispose of their produce through commission agents or directly in the outdoor market place. There is no control, however, over the volume of produce that reaches the Food Terminal, and a surplus arising there deflates prices without regard to the state of supply and demand in the province as a whole. On the fresh-fruit market competition is free for all crops except peaches and exists also among fruit wholesalers and chain food stores. This competition has the cumulative effect of depressing prices whatever may be the supply conditions. Thus, the prices farmers have been receiving for fruit since 1939 have remained almost constant despite a rise of 230 per cent in the cost of production.

Ontario fruit growers have been unable to set up an efficient method of distributing fruit to all parts of the province. Even in years of large soft-fruit surpluses, many small centres in southern Ontario and most towns in northern Ontario complain that seasonal supplies of fresh fruit are inadequate.

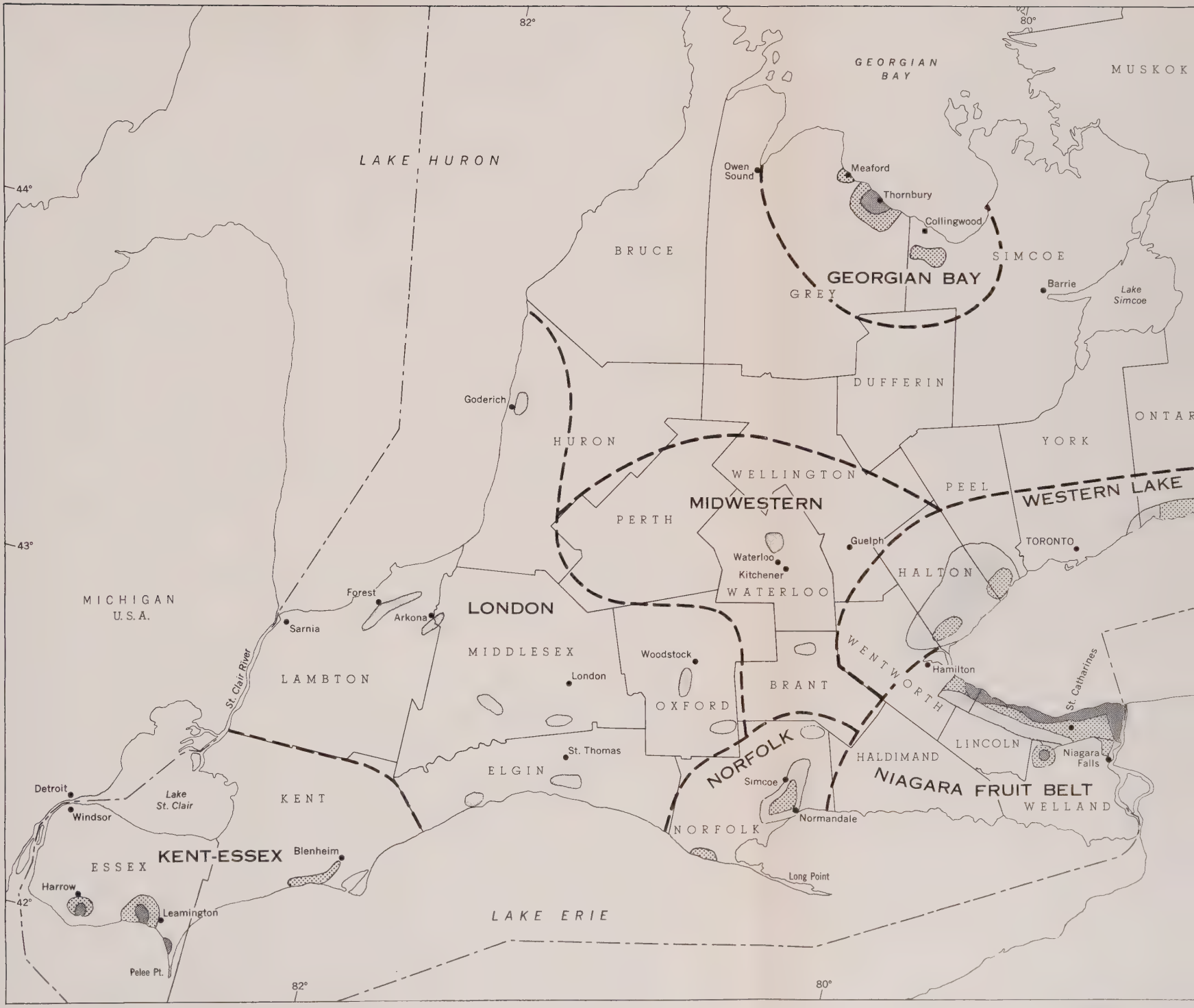
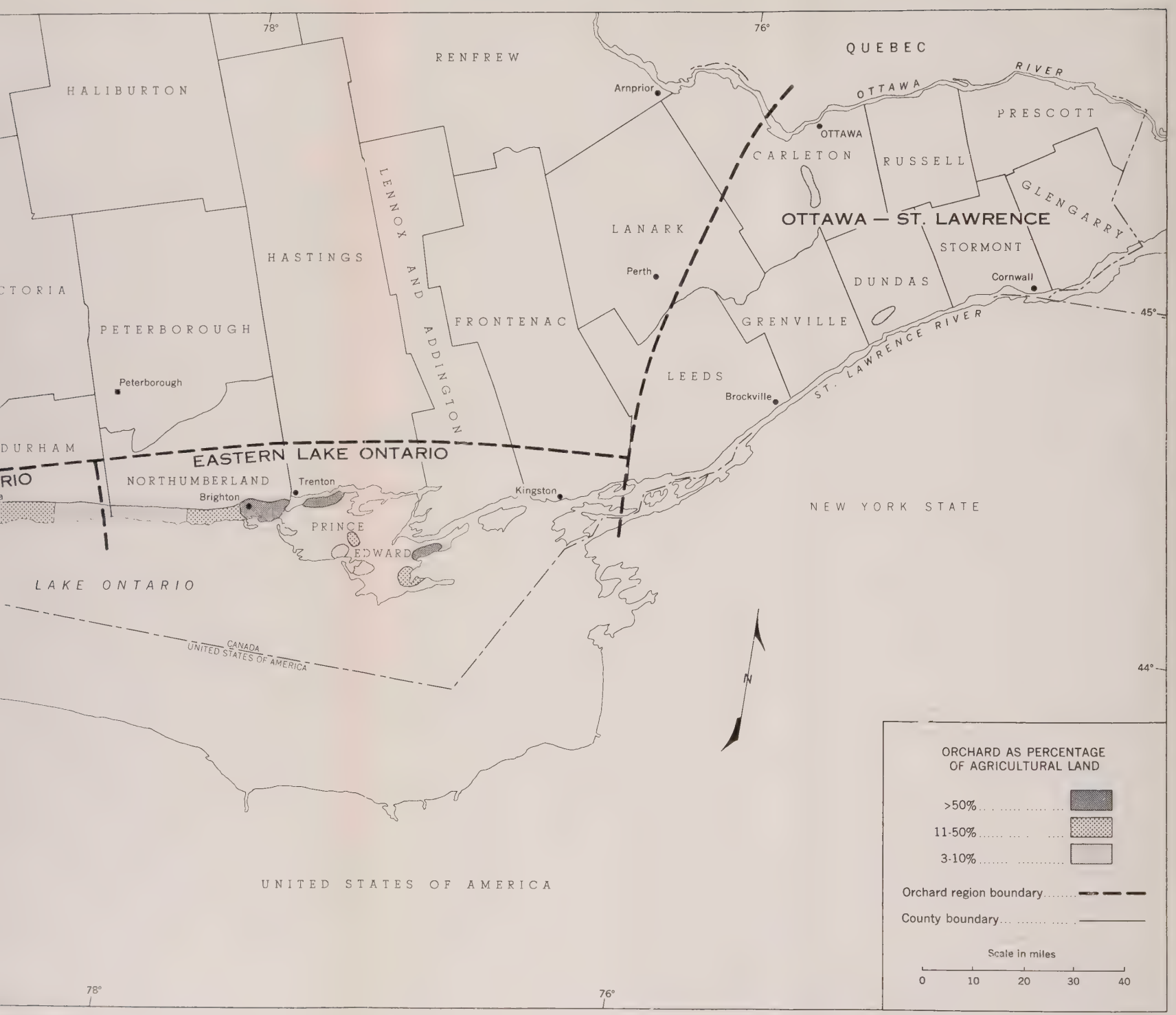


FIGURE 6. The orch



ns of Ontario.

The growers have set up efficient boards to regulate the sale of fruit for processing, but the only fresh-fruit sales so controlled are those of peaches. After a number of false starts and many difficulties, the Fresh Peach Growers' Marketing Board is meeting with moderate success in stabilizing its markets.

A number of leaders in the fruit growing industry in Ontario believe that the marketing and pricing methods used for all fruit crops produced in the province need to be completely revised. As proposed in a recent marketing study made by the Niagara Regional Development Association, this "complete revision" would entail a regulatory board for the entire industry, a board that would control all phases of marketing from the grower to the consumer (Palmer, 1963). Unless such a board is established, it is believed the fruit growers of Ontario are unlikely to benefit from the rapidly growing domestic market.

The main orchard regions of Ontario as delimited in Figure 6 are described briefly in the following subsection. They are modifications of those used by the Ontario Department of Agriculture. For some of them slightly different boundaries would have been preferable, but it was deemed advisable to retain the regions for which statistics are available (Ontario Department of Agriculture, 1962).

REGIONS

Ottawa—St. Lawrence

The Ottawa—St. Lawrence orchard region is the home of the famous McIntosh Red, an apple variety discovered by chance by John McIntosh in 1796. It is therefore fitting that more than 75 per cent of the apple trees in the region are McIntosh.

In the early decades of this century, the region was an important apple-producing area. In 1931 it contained 6,000 acres of orchard—2,000 in the Ottawa Valley and 4,000 in the St. Lawrence Valley. A large proportion of the trees were killed in the winter of 1933–34, and the industry has never recovered.

In 1961 the orchard area of the region totalled only 800 acres. About half of this was in Carleton County, along the banks of the Rideau River, within 20 miles of Ottawa. The rest was concentrated in Matilda Township of Dundas County, along the St. Lawrence River.

A number of new orchards were planted in the Ottawa district in the 1950's, but severe winter damage recurred in several successive winters beginning with 1958 and again caused discouragement. In the summer of 1959, the writer noted a young orchard of 5 acres in which 80 per cent of the trees had been killed the previous winter. Another 33-acre orchard, the largest in the region, lost 1,000 trees in the winter of 1958–59.

In view of the climatic hazards, it is likely that the Ottawa—St. Lawrence orchard region will remain relatively insignificant, producing apples only for the immediate local markets.

Eastern Lake Ontario

The orchards of the Eastern Lake Ontario region lie within the counties of Northumberland and Prince Edward. The densest orchard area is between the towns of Brighton and Trenton, where there are 1,500 acres in a strip less than 2 miles wide and 12 miles long. Apples predominate, covering 93 per cent of the orchard area. Forty-two per cent of the apple trees are McIntosh, 23 per cent Spy and 9 per cent Delicious. The only significant soft fruit is the sour cherry. Peaches have been tried in Prince Edward County, but the winters are too cold, the spring frosts are too late, and the summer heat that matures the crop is insufficient.

The orchards are all planted on slopes close to the lake, where they receive the moderating effects of the water. The clay loams and other loams on which planting is generally done in Prince Edward County are much heavier in texture than those usually considered ideal for orchards. The growers maintain that a clay loam is superior to a sandy loam because it requires less fertilizer, holds moisture better and gives better protection to the tree roots in winter. It may be, however, that such soils are used in Prince Edward County not because they are superior for apple growing, but because most of the suitable sloping sites adjacent to the lake happen to have clay soils.

The orchards of Northumberland County are planted on soils of generally lighter texture found on the Iroquois sand plain between the drumlin hills to the north and the lake to the south.

On the basis of records for 1960–62, the Eastern Lake Ontario region has the highest apple yield in the province (Table 8). With only 3,500 acres, it produced more than 1 million bushels of apples in each of the years 1961 and 1962.

The orchard area of the region was 16,000 acres in 1931. By 1951 it had dropped to 7,000 acres and by 1961 to 3,800. The most striking decreases have occurred east of Trenton. Hastings County, for example, had 2,179 acres of orchard in 1931 but only 384 in 1961.

Many an orchard of less than 3 or 4 acres is being neglected, the farmer having discovered that it does not pay to look after such a small acreage. Some farmers are expanding their orchards to between 20 and 50 acres, thereby making orcharding their most important operation. Only occasionally, however, is orcharding the sole source of income. Most farmers in this region consider apples as an important cash crop in a mixed farm operation with either a dairy or beef specialty.

Western Lake Ontario

The Western Lake Ontario orchards also lie primarily along the lake. West of Toronto, where the winters are more moderate, orchards are also found considerably farther inland.

Apples are the predominant crop, taking up 88 per cent of the orchard area. Although their acreage is twice what it is in the Eastern Lake Ontario region production is not quite so high (Table 8). McIntosh (33 per cent) and Spy (22 per cent) are the main varieties. Owing to the milder climate, the Delicious (13 per cent) has been planted more extensively here than in the more easterly region. Pears are the next most important tree fruit, followed by sour cherries and plums and prunes.

The orchards are planted largely on the Iroquois clay plain between morainic hills and the lake. As in Prince Edward County, the soils used are loams and clay loams and are considerably heavier in texture than most of the province's other orchard soils.

In the part of the region that lies east of Toronto, the orchard-and-livestock pattern is very much as it is in Northumberland County, the only difference being that orcharding is less highly specialized. West of Toronto, vegetables and small fruits for the city's market as well as canning crops are important, but there are several districts where orcharding is by far the most important agricultural activity.

In York County, which surrounds Toronto, and in the section of the lake plain between Toronto and Hamilton, urbanization has had a considerable effect upon orcharding. York County's orchard area, which was 3,900 acres in 1931, was down to 1,800 acres in 1951 and to 620 acres in 1961. In the last decade, Peel County has lost 1,500 acres and Halton County 2,600. As orchards are uprooted close to the lake, new orchards are planted farther inland. Chinquacousy Township, for example, in the second tier of townships from the lake, showed a gain of 400 acres of orchard between 1951 and 1961. If urban growth continues, the Toronto-Hamilton section of this orchard region will probably continue to decline. What orchard activity remains will have shifted inland, away from the present lakeshore concentration.

Table 8

Orchard acreages and apple production for the orchard regions of Ontario

Region	Total orchard acreage*			Apple acreage 1961	Average annual apple production 1960–62 (bushels)
	1931	1951	1961		
Ottawa—St. Lawrence	6,215	1,761	795	795	194,450
Eastern Lake Ontario	16,080	6,904	3,768	3,500	967,696
Western Lake Ontario	23,480	15,200	8,289	7,296	896,242
Niagara Fruit Belt	18,158	29,829	20,527	1,475	154,433
Norfolk	5,648	3,648	3,624	2,761	635,214
Kent-Essex	6,788	4,679	4,523	1,276	188,717
London	24,025	8,188	4,408	3,588	666,667
Midwestern	9,652	2,405	650	600	47,512
Georgian Bay	13,620	5,320	4,687	4,565	988,605

*The 1931 acreages are from the *Census of Canada*, 1931, Ontario Census of Agriculture, Table 12; the 1951 acreages are from the *Census of Canada*, 1951, v. VI, Agriculture, Pt. II, Ontario, Table 20; the 1961 acreages and production statistics are from *Agricultural Statistics for Ontario*, Ontario Department of Agriculture, 1960, 1961 and 1962. The acreages for 1931 and 1951 are those of counties with more than 200 acres of orchard. Thus restricted, they are more readily comparable with the Ontario Department of Agriculture acreages for 1961, which include commercial orchards only.

Niagara Fruit Belt

The Niagara Fruit Belt, stretching from Hamilton to Niagara Falls, is Ontario's principal soft-fruit region, constituting more than 70 per cent of the provincial acreage of peaches, cherries, pears, and plums and prunes. Peaches, which account for 42 per cent of the Niagara orchard area, are the main tree crop, followed in order by cherries and pears. Apples are relatively insignificant, covering only 7 per cent of the orchard area. In addition, the Niagara Fruit Belt is important for its grapes, which occupy almost as much of its area as do peach orchards.

In the 1880's the Niagara region's apple production was greater than its output of any other fruit. The change that made peaches dominant began around 1890, when Nova Scotia and British Columbia began to compete with Ontario for the British apple market. At a disadvantage in this competition because of the high cost of transporting apples to the Atlantic seaboard, the Niagara farmers began to plant peaches, for which there was a local market and which provided a greater return per acre.

The Niagara peach growers had a comparative advantage. They were next door to a large and growing market, and the climate for peaches was superior to that of any other part of the province. A series of very cold winters about the turn of the century killed most of the peach trees in Kent and Essex but caused only slight damage to the Niagara peach orchards. Thus, by 1905, the Niagara Fruit Belt had a virtual monopoly in peach production, and in the following decades the peach acreage increased rapidly. By 1931 there were 7,000 acres, and by 1951 there were 14,000. Since 1951, owing to urban expansion, the peach orchards of the Niagara Fruit Belt have declined by several thousand acres.

The superiority of the Niagara peach climate is due to the location of the Fruit Belt on the south side of Lake Ontario. The lake's moderation of the cold air masses greatly diminishes the danger of injury from winter temperatures. It is generally recognized that temperatures of −12°F or lower will kill dormant peach blossoms and that one of −20°F or lower will injure the peach wood. At Vineland, in the centre of the Fruit Belt, the temperature has dropped to −12°F only three times in 30 years and has never reached −20°F. The Hamilton area falls a little short of this record, but the St. Catharines area surpasses it. Within Ontario, only the Leamington district of Essex County can compare with the Niagara region in this regard (Mercier and Chapman, 1955–56).

The proximity of a large body of water, such as Lake Ontario, that is slow to warm up also delays the blossoming of peaches a week or two in the spring—long enough to make them miss most of the spring frosts. In the Harrow and Leamington peach districts in Essex County the average date for the last spring frost is about the same as in the Niagara Fruit Belt, but it is more likely to damage the blossoms because of the earlier bloom date. There is, in fact, less chance of spring frost damage to peaches in the Niagara Fruit Belt than in any other peach growing region of North America outside California (Krueger, 1959).

Most of the areas of intensive orcharding in the Niagara Fruit Belt are concentrated on the sandy soils of the Iroquois Plain, which lies between the lake and the prominent Niagara Escarpment and varies in width from about 2 miles in the west to about 7 miles in the east. In the western end of the Fruit Belt, considerable orchard is found on an end moraine that runs along the brow of the Escarpment. The moraine slopes provide good air drainage; and the soils, although they are of clay loam, are light enough in texture to provide adequate drainage for tree crops other than peaches. The other important orchard district above the Escarpment is located on the Fonthill Kame, a huge gravelly hill that rises a couple of hundred feet above the surrounding countryside.

In a humid climate both peaches and sweet cherries require a deep well-drained sandy or gravelly loam, a soil that the writer has termed "tender-fruit soil" (Krueger, 1959). On this kind of soil, which covers only part of the lake plain, the peaches and sweet cherries are concentrated. The clay soils are planted to other tree crops and grapes. Above the Escarpment, the Fonthill Kame district is the only one that has peach orchards of any importance.

The Niagara Fruit Belt is an area of highly specialized fruit-growing. On the lake plain there is no mixed farming, agricultural activity consisting entirely of orcharding, viticulture and the cultivation of small fruits and vegetables. Above the Escarpment, the cultivation of orchards and vineyards is part of a mixed farm operation in which the specialty is beef-raising or dairying. The Fonthill Kame district, however, is gradually turning away from all but fruit.

The farm holdings are very small in the intensive part of the Fruit Belt, below the Escarpment. About half of the fruit growers own less than 10 acres; very few have more than 25 acres. The occupants of many of the smaller holdings also have full-time jobs in the city. It is generally agreed that many orchard holdings should be enlarged to a more economic size, but the inflation of land prices caused by urban demand for land has made it economically unfeasible for growers to add to their holdings.

About 60 per cent of all the Niagara peaches, cherries, pears and plums are sold to processors. It is the part of their produce sold on the fresh-fruit market, that presents Niagara growers with most of their marketing problems. The fruit must be harvested and sold within a very short time. In bumper-crop years the pressure to sell, coupled with an inadequacy of marketing machinery, often forces prices down, almost to the cost of production or even below it.

Sixty-five per cent of the sales of fresh Niagara peaches are made in Ontario, about half of them in Metropolitan Toronto or its environs. Because of competition from local growers, very few Niagara peaches are sold in the Norfolk, London or Kent-Essex regions. More than 90 per cent of the peaches sold outside Ontario go to Quebec, primarily to the Montreal and Quebec City markets (Haslett and McInally, 1954).

Uncontrolled urban expansion poses a threat to the Niagara Fruit Belt. Low-density urban development, spreading out in all directions from the major cities, is occupying large acreages of prime fruitland. Between 1951 and 1961 the orchard area declined by 3,500 acres, most of which had been used for peach growing. In recent years tender-fruit soil has been lost at the rate of 500 acres a year. By 1960 some 40 per cent of its original area had been used for urban purposes. The farmers have offered little resistance to this encroachment because the high prices they obtain for their farms provide a profitable escape from marketing problems and the decline in fruit-growing profits.

Urban expansion and the continued existence of a prosperous fruit-growing industry in the Niagara Fruit Belt are not, however, necessarily incompatible. If urban development were controlled so as to be more orderly and compact and if its growth were directed, where possible, to the less valuable fruitland, there would be room for a population increase of 1 million without serious reduction of the present orchard land. In some areas, such as the Fonthill Kame district, orcharding can be intensified. In addition, orchard yields have been constantly increasing, and irrigation would boost them even further.

Since 1955, the Ontario Department of Agriculture (Irving, 1957), the Ontario Department of Municipal Affairs (Sinclair, 1961) and the Ontario Department of Economics and Development (1963) have made intensive economic and land-use surveys in the Niagara Peninsula. All agree that, with the right economic framework and effective regional land-use planning, one of the most valuable horticultural regions on the continent could be kept in production. They also agree that the alternative is the ultimate disappearance of the Niagara Fruit Belt as an important orchard region.

For political reasons most of the recommendations of the first two government research groups were never published. The third group, however —that of the Department of Economics and Development–recommends in its recent economic survey that some planning organization be given statutory authority to devise and implement a regional long-term land-use program. The report makes it clear that the responsibility of initiating effective regional planning lies with the provincial government. It adds that any effort to arrest the decline of Niagara fruitlands must include measures to ensure the fruit farmer a reasonable livelihood from his operations. Such measures require the active co-operation of fruit growers, processors and both the Ontario and the Canada Department of Agriculture.

Norfolk

In Norfolk County, intensive orcharding is carried on within 10 miles of Lake Erie in a small area around the town of Simcoe. Apples, the most important tree crop, cover 76 per cent of the orchard area followed by peaches and cherries, which account for 13 per cent and 5 per cent respectively.

Most of the 460 acres of peaches are in two narrow strips adjacent to the lake—one at Normandale and another west of Long Point. This lakeshore location gives protection from winter low-temperature injury. Three or four miles inland the winters are too cold for successful commercial peach production. At Simcoe the critical low temperatures of $-20°F$ and $-12°F$ occur in two and 14 years out of 30 respectively (Mercier, 1955-56).

Both peach and apple orchards are planted in the main on well-drained or sandy loams. These soils are lighter in texture than most of the soils used for apples in the orchard regions around Lake Ontario.

The Norfolk orchard area is on the southeast edge of the Southern Ontario Tobacco Belt. A few farmers combine orcharding with tobacco- and corn growing.

Orchards in Norfolk average 20 acres, but there are many of 30 to 40 acres. They stand the winter well, and their yields are high. Since the orchard soils are extensive, the industry's expansion depends not so much on acreage as on the economics of apple growing. In 1951-61 the Lake Erie orchard regions of Norfolk and Kent-Essex were the only ones in the province that did not lose acreage.

Kent-Essex

In the latter half of the nineteenth century, apple orchards were planted on most of the farms in Kent and Essex counties. In the 1890's peach trees were planted on a large scale on the light textured soils near Leamington, but the very cold winters between 1897 and 1904 killed most of them. About the same time the apple-orchard industry was discouraged by a serious outbreak of the San José scale disease (Morrison, 1954; Siller, 1963).

By the 1920's orchards were evenly distributed among all the townships of these counties. Between 1931 and 1951 the smaller orchards in most parts of the region had gone out of production while orcharding became more intensive in the districts shown in Figure 6.

The 4,500 acres of orchard at present in this region are concentrated in three small areas near Lake Erie around the town of Blenheim, in Kent County, and Leamington and Harrow, in Essex County. With more than 2,500 acres of peach trees, the Kent-Essex region is second only to the Niagara Fruit Belt in peach production. Peaches account for 57 per cent of the orchard area; apples for 28 per cent. Other tree fruits are relatively insignificant.

Processing companies purchase large amounts of Kent-Essex apples, peaches and pears for baby-food products. Southern Ontario provides the largest market for the region's fresh fruit. Substantial quantities of peaches are also shipped to the Province of Quebec and the Detroit area. Detroit and its environs, with a population about equal to that of all Ontario, buys almost one third of Essex County's fresh apples and may, in the future, be an even greater market for the fresh fruits of Kent-Essex (Haslett and Ware, 1951).

The orchards of the Kent-Essex region are planted primarily on gentle slopes with deep well-drained soils of sandy or gravelly loam. In Kent County they lie on a long, narrow, gravelly ridge formed by an old glacial-lake shoreline. There is no orchard at all on either side of the ridge. Most of the orchards here are small, and as much as 50 per cent of the peaches, cherries and plums are sold at numerous roadside stands along the highway that follows the ridge. In the Harrow and Leamington districts of Essex County the most extensive orchard plantings have been made on Fox and Harrow sandy loams. Because of the high yield and high quality they produce, these deep, light-textured, well-drained soils are considered best for peaches. Where there is enough slope to help drain off excess moisture, some peach growers are having success on heavier-textured loams, which in dry years are better for peaches than the sandy loams. Apple orchards are found predominantly on the lighter-textured soils, but a few of them appear to be doing equally well on the heavier soils. In dry summers some growers irrigate orchards planted on lighter soils, but the irrigation is on a trial-and-error basis. With a more scientific approach to irrigation, it is likely that yields could be greatly increased in dry years. Whether irrigation is economically feasible is another question.

In Point Pelee National Park a 70-acre apple orchard has been planted on Eastport sand, which is nothing more than recently deposited beach sand and is very droughty. Tree growth in this orchard is very slow, and the annual yield is usually very low. In wet years however there is a good apple crop, which is free to the public for the picking—to the irritation of the region's commercial growers.

The Kent-Essex region is favored with higher summer temperatures and a longer growing season than the Niagara Fruit Belt. Its peach harvest season is about 10 days earlier than that of Niagara and thus gives Kent-Essex the advantage of selling more peaches at the higher prices prevalent at the beginning of the season.

The winters of the region are similar to those of the Niagara Fruit Belt. The frequency of temperatures of $-20°F$ and $-12°F$ (critical for dormant peach wood and buds respectively) are

the same at Leamington as they are at Vineland, in the Niagara Peninsula. There is therefore very little risk of winter injury to the peach trunk and branches, and the chance that winter frost damage to blossom buds will result in some crop loss occurs in only three out of 30 years (Mercier, 1955–56). In January 1962 at Harrow the temperature dropped to −15°F, its lowest since the cold winter of 1933–34. Surprisingly, this cold snap damaged the blossom buds only on the most tender varieties of peaches. This points up the complications involved in assessing the suitability of orchard climate from the analysis of meteorological statistics (Krueger, 1959).

In recent years winter injury to the roots of peach trees has been extensive. A detailed study conducted by the agricultural research station at Harrow has shown that temperatures just slightly below zero can kill or seriously injure such trees if there is insufficient snow to help insulate the roots. The damage has been greatest on the lighter-textured soils and in orchards with inadequate cover crop (Weaver, 1963).

Severe loss of peach trees due to root injury was first noticed in 1958–59, when about 20 per cent were killed. There was serious tree kill and injury again in 1960–61 and 1962–63. A survey carried out by the agricultural research station at Harrow in 1963 showed that 45 per cent of the peach trees 11 to 19 years old and 20 per cent of those one year to four years old had been lost by low-temperature root injury. (Wensley, 1963).

The losses have been disastrous to a large number of growers, many of whom are debating the advisability of continuing in the hazardous peach-growing business. The tree losses have been heaviest on the Fox sandy loam which has heretofore been considered the best peach soil.

Because they blossom earlier, the peach trees of Kent-Essex are in greater danger of spring-frost injury to blossoms than those of the Niagara Fruit Belt. This, however, only reduces the crop for a year and so is less serious than tree damage.

The orchards of the Leamington and Harrow districts are generally very large, being mostly between 20 and 40 acres. The trend has been toward orcharding and away from vegetable growing; until 1958–59, when the peach trees were damaged by the winter temperatures, it was decidedly toward complete specialization. Some farmers combine orcharding with dairying, while others produce, in addition to fruit, such cash crops as tobacco, corn, soybeans, asparagus, vegetables and flowers.

In the 1950's, the larger net profit derived per acre led to a rapid expansion of peach orchards in the two districts. The result in many instances was the planting of poor nursery stock, the planting of peach trees on low-lying, poorly drained soil and the introduction of the poor cultural practices of novice growers. Many were greatly discouraged on finding that their young peach trees were a much inferior variety to what they had ordered from the nursery-stock company. The peach trees lost since 1958 have been only partly replaced, and the net result of the developments of 1951–61 is that in orchard acreage the Kent-Essex region has merely held its own.

The loss of prime peach land to urban expansion in the Niagara Fruit Belt has led to conjecture about the possibility of the Kent-Essex region replacing the Niagara peach production in the future. Interviews with Kent-Essex farmers indicate that one of the factors influencing them to plant more peach orchards was the probability of the loss of the Niagara fruitland. The substitution, although it would lessen the dependability of supply, is theoretically possible. In the Kent-Essex region within 10 miles of the lake, there are considerably more than 40,000 acres of very good tenderfruit soil. If from this acreage are subtracted the area already planted with orchards and that occupied by towns, roads and the like, there remain more than 20,000 available acres suitable for the production of peaches and sweet cherries. This land not only could replace the Niagara peach and cherry orchards but is equal to the whole Niagara orchard area.

However, the recent Kent-Essex experience with winter peach-tree losses and difficulties with nursery stock has greatly discouraged many orchardists and potential orchardists. Although improved methods of culture and more hardy rootstock should reduce peach-tree losses, it is doubtful that large numbers of farmers will turn in the near future from a safe and known type of agriculture to the hazardous business of peach-growing. It is highly probable that production will remain at about its present level. The complete disappearance of the Niagara orchard industry would, however, undoubtedly result in a great increase in the Kent-Essex peach acreage.

London

The London region extends from Lake Erie to Lake Huron. The orchard statistics for the region (Table 8) include the counties of Elgin, Middlesex and Lambton as well as large parts of the counties of Oxford and Huron. Orchards are scattered over the entire region but are concentrated in the districts indicated in Figure 6. Orcharding is usually combined with other types of farming, often as a sideline cash crop rather than as an important part of the farm operation.

Because the orchards are widely dispersed, the London region does not seem to be an important orchard area. Its 4,400 acres, however, make it roughly equal to the Georgian Bay or the Kent-Essex region. In apple production it ranks fourth in the province.

Oxford County is one of the region's more important apple-producing districts. In 1950–60 its apple yield averaged 139,000 bushels annually. The county boasts one of the most successful and progressive apple co-operatives in the province—the Oxford Fruit Growers Co-operative, organized in 1931, which has done an excellent job of marketing apples in northern Ontario, western Canada and the United Kingdom. In 1959 this became the first organization to ship Ontario "controlled-atmosphere" apples as far west as Vancouver.

Although apples are by far the most important tree crop (they make up 80 per cent of the total), a few districts have peach orchards that supply a large part of the local fresh-peach demand. Most of the 300 acres of peaches are in Lambton County, on a gravelly ridge near Forest and in another district near Arkona. Although winter damage to peach wood is negligible in these districts, the chance of winter injury to dormant peach-blossom buds is about one out of every three years. Farther north, there are several peach orchards near Goderich in Huron County. Closeness to the lake, a sloping site, well-drained gravelly soil, and good management have combined to make these Goderich peach orchards surprisingly successful.

In earlier days the London region was a leading apple-orchard area. In 1931 its orchards covered 24,000 acres. Huron County, with more than 6,000 acres, was first. The other counties had between 3,000 and 5,000 acres each. After the freeze of 1933–34 and the later loss of the British export market, orcharding declined rapidly. The greatest loss occurred in Huron County, where the 1931 area had decreased by 1951 to 800 acres. In 1961 acreage stood at 750, of which considerably more than half was in Goderich Township, where the town of Goderich is situated.

Midwestern

The Midwestern region is the least important in Ontario. Its interior location results in severe winters that restrict cultivation to apple growing.

Most of the commercial apple-orchard area is in Waterloo and Brant counties. The orchard sites are all on slopes with light-textured well-drained soils. Within Waterloo County most of the orchards are on the sandy and gravelly hills of the kame moraine north of Kitchener-Waterloo.

At one time the Midwestern orchard region was important. In 1931, when it had more than 9,000 acres, it ranked ahead of both the Norfolk and the Kent-Essex regions. Since then its orchard area has been constantly declining. By 1961 there were only 660 acres of commercial orchard. The 1961 statistics, however, excluded a number of orchards that yield apples for home consumption and for neighbors and townsfolk who like to go out to the farm for their apple supply.

Waterloo County produced a considerable amount of apple butter. Some of it is sold locally in bulk; some is canned and sold through food supermarkets.

Georgian Bay

The moderating effects of Georgian Bay on winter temperatures have made successful commercial orcharding possible in the Georgian Bay region, which is farther north than any of the other important Ontario orchard areas. The orchards lie between the bay and the Niagara Escarpment, which rises 1,000 feet above the lake plain at Collingwood. The commercial area is divided among three districts—Thornbury, Meaford and Collingwood.

At Thornbury, in the broad mouth of the Beaver Valley, is the largest commercial acreage, about four-fifths of which is on gently sloping sites of Brighton sand and sandy loam that has been formed on beach and deltaic deposits. For most farmers whose land is on this soil type, orcharding is the main source of income. The average orchard size is between 20 and 40 acres. Some of the growers on the more droughty phases of these sandy soils find irrigation profitable during summer dry spells. On the silt and clay loams farther up the valley slope there are

smaller orchards that are sidelines to mixed farm operations.

The orchards in the Meaford district occupy Brighton sandy loam on beach and deltaic deposits in the mouth of the Bighead Valley. As there are only about 400 or 500 acres of orchard, much good soil remains for orchard expansion.

About 2 miles south of Collingwood there are several dozen large commercial orchards on sandy soil formed on a glacial-beach ridge. In this district, apple growing has been combined with truck farming and the production of canning crops. There are many large fields of potatoes, asparagus, cabbage and onions, as well as lesser quantities of other small fruits and vegetables.

The Georgian Bay region is famous for the quality of its Northern Spy apples, which once covered a larger acreage than any other variety. Today, although the Northern Spy accounts for 34 per cent of the apple trees in the region, McIntosh (40 per cent) has taken the lead.

As in many other regions, apple acreages declined rapidly in the 1930's and 1940's. Over a broad area smaller orchards have disappeared while in the three districts just described orcharding has become more intensive. Bruce County, which in 1931 had more than 3,000 acres of orchard, today has only a few farmstead orchards and no commercial apple production.

THE ORCHARD INDUSTRY OF BRITISH COLUMBIA

LOCATION, LAND TYPE AND CLIMATE

More than 90 per cent of the orchards of British Columbia are in the Okanagan Valley, which runs some 120 miles from the United States boundary north to Salmon Arm, on Shuswap Lake. The only other significant area is that around Creston, just south of Kootenay Lake, where there are 1,400 acres of orchard. Small and generally scattered orchards, making up less than 4 per cent of the provincial acreage, are found in the Vancouver Island-Lower Fraser, Upper Fraser-Thompson, and Grand Forks-Kootenay-Arrow Lakes regions (Figure 7).

The principal tree crop is apples, which are produced on 62 per cent of the orchard acreage. The Delicious varieties are grown on 42 per cent of all apple trees (Red Delicious, 33 per cent). McIntosh trees rate second with 26 per cent of the total, followed in order by Spartan with 10 per cent and Newton with 4 per cent. Increasingly in recent years, British Columbia growers have been planting dwarf and semidwarf apple trees. They are sometimes planted between the rows of young standard apple trees. Dwarf trees provide a high yield per acre; the trees are easier to care for and the fruit easier to pick. Because they are closer to the ground, however, they are more susceptible to frost injury; because they are more numerous per acre, they are more expensive to replant.

Pears, cherries (primarily sweet) and peaches are produced on 30 per cent of the orchard acreage, while apricots, prunes and plums account for 4 per cent each. Some pears, cherries, and prunes and plums are grown in all regions; peaches and apricots are produced almost entirely in the South Okanagan. Although prunes and plums are grouped in the statistics and maps included with this paper, prunes are by far the more important of the two. A few crab apples are also grown in most regions.

All the orchards of British Columbia except the few acres on Vancouver Island are on the lower slopes and terraces of river valleys or along the sides of lakes. Since most of the interior is climatically marginal for tree fruits, these sloping sites are important in making fruit growing possible within the province. Cold air flows down the slopes and builds up pools that can reach tens of feet in depth on the valley floors. Frost damage ensues when the pool of cold air deepens to the height of the tree branches. Thus the best orchard site is on a sloping terrace high above a broad valley floor. Gullies cutting across the terrace are a further help in draining the cold air away from the orchards.

Because of the greater continentality and elevation of the eastern part of the province, the climate of the valleys of southern British Columbia generally becomes milder from east to west. Climatic statistics for Newgate illustrate why there are no orchards in the Rocky Mountain Trench, which lies between the Rocky Mountains and the Purcell Range. The frost-free period at Newgate is only 93 days, the mean January temperature 19°F and the record low −40°F. Creston, the most easterly of the orchard regions, has a growing season of 120 days, a mean January temperature of −23°F and a record low of −27°F. Oliver, at about the same latitude but more than 100 miles farther west and

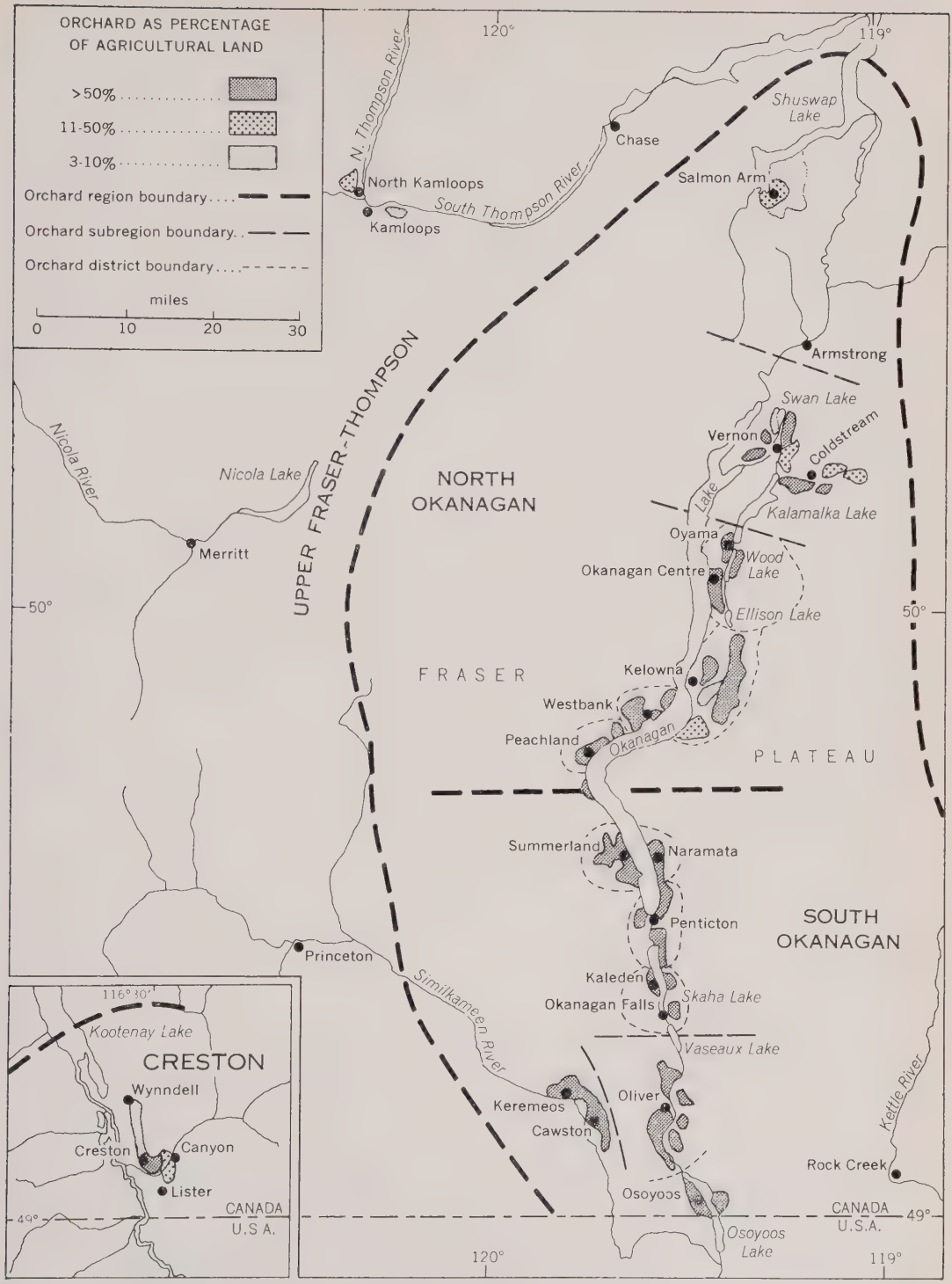


FIGURE 7. The orchard regions of British Columbia.

1,100 feet lower in elevation, has 32 more frost-free days, and its mean January temperature and record low are respectively 2 and 6 degrees higher than those of Creston. Farther north in the Okanagan Valley, the proximity of Okanagan Lake further increases the frost-free period and moderates the temperatures of such stations as Penticton and Summerland. North of Summerland, however, the frost-free period becomes shorter and the winters more severe. At Salmon Arm, the most northerly of the main orchard districts, the frost-free period is 153 days, the January mean 23°F. On Vancouver Island and in the Lower Fraser Valley the growing season is the longest in the province and the winters the mildest, perhaps too mild for apple trees, which require a continuous period of chill for a proper break in the rest period. If the chill period is insufficient or if it is prematurely broken by a mild spell, blossom time is usually staggered, the fruit does not set properly, and production is considerably lowered.

In all the orchard regions outside those of Vancouver Island and the Lower Fraser Valley, there is periodic tree damage due to extremely cold winter temperatures. Since 1900, the fruit trees in most of the orchard regions have suffered severe low-temperature injury in about one out of every seven years.

The winter of 1949–50 was the most devastating of all. The record low temperatures that struck most regions killed about 20 per cent of all the trees in the province. While all tree fruits were damaged to some degree, damage was greatest among apples and peaches, which had a tree-kill rate of 30 per cent. The tree-kill was proportionately highest in the Upper Fraser-Thompson region, where 54 per cent of the fruit trees were lost. The best record was, surprisingly, at Creston, which did not receive the brunt of the cold wave and consequently had a tree-kill of only 4 per cent. Even in the Oliver-Osoyoos area, at the southern end of the Okanagan Valley, the tree-kill rate was as high as 27 per cent.

Further losses occurred when, in November 1955, an early cold snap plunged temperatures below 0°F. Because the trees had not had time to harden properly, a large number died, many of them young trees planted to replace the losses of 1950 (Krueger, 1963).

Spring-frost damage to fruit blossoms is another major hazard in the orchard areas of British Columbia. In districts not adjacent to a lake or with insufficient slope to provide adequate air drainage, there is a risk of blossom damage almost every year. Even in the better districts the chance of some spring-frost damage exists in one year out of two. In the Okanagan Valley, spring frosts reduced the production of peaches, apricots and cherries in five years in the 1950–60 decade (British Columbia Department of Agriculture, 1950–60).

In the principal orchard regions the semiarid climate has made irrigation necessary. Although this involves additional expense, it makes the yields much higher than in regions that depend upon natural precipitation. The British Columbia apple-tree yield is thus from 3 to 4 bushels higher than in eastern Canada. The dry climate also makes disease control easier. Apple scab is not nearly so difficult to control as in the East, and brown rot, which is a plague to Ontario peach growers, is relatively unknown in the Okanagan Valley. Insects, however, thrive in the hot dry climate, and in some years infestation with codling moths and mites reaches epidemic proportions.

The texture of orchard soils ranges from coarse gravel to clay. The soils on which orchards are planted in British Columbia are formed primarily from glacial tills of glacio-fluvial deposits. The best peach soil in the province is a silt loam. Because of the small amount of precipitation (from 10 to 20 inches a year) and the resulting reliance on irrigation, which makes control of the quantity of moisture possible, drainage is not so important for the orchards of British Columbia as it is for those of eastern Canada. For instance, while the best peach soils in Ontario are sands and sandy loams, the best peach soil in British Columbia is a silt loam. In British Columbia the lighter-textured soils require a more frequent and heavier application of irrigation water and fertilizer. They also expose tree roots to a greater risk of frost damage. The heavier clays, on the other hand, restrict root development too much for such tender fruit crops as peaches, apricots and sweet cherries.

ORCHARD TRENDS AND ECONOMIC CONDITIONS

The Okanagan Valley has not always been the most important orchard region in British Columbia. Until about 1890, in fact, orchards were planted in most of the valleys of southern British Columbia *except* the Okanagan. The first fruit trees were planted in the early 1840's around Hudson's Bay Company forts where

Victoria, New Westminster and Hope now stand. They did not require irrigation and were close to the markets of Victoria and Vancouver.

Between 1840 and 1910, orchards were planted along the banks of the Upper Fraser as far north as Lillooet, along the South Thompson as far east as Shuswap Lake, throughout the Okanagan Valley, along Upper and Lower Arrow Lake, Slocan Lake, the Columbia River south of Castlegar, the Kettle River in the vicinity of Grand Forks and the banks of the southern half of Kootenay Lake, and at Creston, on the Kootenay River (MacPhee, 1958).

In 1901, according to the census, the Okanagan Valley lay outside the greater part of the orchard area. A superior climate, however, coupled with spectacular promotion by real-estate speculators, led in the early 1900's to its rapid settlement. By 1911 the Okanagan had become British Columbia's leading orchard region, and by 1920 it had more than two-thirds of the province's fruit trees. Its orchard supremacy within the province has been increasing ever since.

In the early part of the twentieth century, primarily owing to the Okanagan orchard boom, the fruit trees of British Columbia multiplied very rapidly. By 1920 they stood at 1,900,600 a total not exceeded until 1950, when the orchard survey showed 2,477,900 fruit trees. A slight decline has since resulted from the widespread losses suffered during the winters of 1949–50 and 1955–56 (Table 9). The increases in orchard area that occurred between 1920 and 1955 were accompanied by a rapid increase in tree yields. In 1924–27, for instance, the average annual apple yield per bearing tree was 3.8 bushels; in 1954–57 it reached a high of 9.5 bushels. In the same interval, the per tree yields of pears, peaches and apricots approximately doubled. Only cherries and the prune-and-plum crop have shown no consistent increases. In 1959–62, undoubtedly owing to damage caused by the freezes of 1949–50 and 1955–56, the apple and pear yields decreased slightly (Table 10). When low temperatures strike, the consequent reductions in pear and apple yields do not usually show until several years later.

From 1920 to 1950, primarily because of a rise in the apple and soft-fruit yields and in the number of soft-fruit trees, fruit production constantly increased. Apple production rose from the 1921–25 annual average of 3.3 million bushels to a high of 8.9 million bushels for 1946–50. In the two five-year periods that followed 1950, the apple-production average dropped respectively to 6.4 million and 5.3 million bushels a year (Table 11).

Of the soft fruits, peaches have shown the most striking increase in production, rising from an annual average of between 100,000 and 200,000 crates in the early 1920's to almost 2 million crates in the late 1940's. In the year following the 1949–

Table 9

Fruit trees in British Columbia, by orchard regions, 1920-60

Region	1920	1930	1940	1950	1960
Upper Fraser-Thompson	37,725	26,740	47,224	71,902	19,257
Grand Forks-Kootenay-Arrow Lakes	469,564	246,289	132,697	78,148	16,107
Creston	110,328	111,307	99,400	130,348	81,031
North Okanagan	908,428	883,500	891,650	1,161,323	1,124,488
South Okanagan	374,596	485,774	680,083	1,036,187	1,172,976
Okanagan Total	1,283,024	1,369,274	1,571,733	2,197,510	2,297,464
Grand Total	1,900,641	1,753,610	1,851,054	2,477,908	2,413,859

Sources: *Orchard Surveys*, British Columbia Department of Agriculture, 1955 and 1960; summaries of earlier issues of *Orchard Surveys* contained in *Report of the Royal Commission on the Tree-Fruit Industry of British Columbia*, 1958.

NOTE 1: Suitable records for Vancouver Island and the Lower Fraser Valley are not available. Acreages would have been more meaningful and better for comparison with other regions in Canada, but the statistics for past years are in tree numbers only. It is impossible to convert these accurately to acreages for a long span of years because the space between trees changes substantially from decade to decade. The problem of comparison has been even more complicated by the recent trend toward dwarf trees.

NOTE 2: For a breakdown of fruit trees into apple and soft-fruit producers by subregion see Krueger's "The Physical Basis of the Orchard Industry of British Columbia", *Geog. Bull. 20.*

Table 10

Average annual yield per bearing fruit tree, Okanagan Valley, 1924-62

Tree crop	1924–27 1925	1929–32 1930	1933–37 1935	1939–42 1940	1944–47 1945	1949–53 1950	1954–57 1955	1959–62 1960
Apples (bushels)	3.8	5.4	6.2	6.7	9.5	8.4	9.5	8.0
Pears (boxes)	2.3	3.4	4.4	4.6	5.8	4.6	4.8	3.3
Peaches (crates)	2.1	5.6	5.7	5.8	9.2	4.7	5.6	5.8
Apricots (crates)	2.4	3.2	3.7	5.8	7.0	4.1	4.3	4.5
Cherries (crates)	4.0	4.6	3.9	4.1	6.2	4.0	2.8	3.3
Prunes and plums (crates)	4.4	5.3	6.3	6.6	9.0	6.0	4.6	5.2

Sources: The yields from 1924–27 to 1954–57 are from E. D. MacPhee, *Report of the Royal Commission on the Tree-Fruit Industry of British Columbia*, 1958. Those for 1959–62 were computed from production statistics provided by B.C. Tree Fruits Ltd., and the number of trees from *Orchard Survey of the Okanagan Valley*, British Columbia Department of Agriculture, 1960.

NOTE 1: In the double-lined column headings, the upper line gives the production period, and the lower line the tree-survey year.

NOTE 2: The weights corresponding to the measurements used are as follows: bushel (apples), 40 pounds; box (pears), 42 pounds; crates (peaches, apricots and cherries), 20 pounds; and crates (prunes and plums), 15 pounds.

Table 11

Average annual apple production in British Columbia, 1921-60

(bushels)

1921–25	3,272,000
1926–30	4,208,000
1931–35	5,062,000
1936–40	5,857,000
1941–45	6,734,000
1946–50	8,879,000
1951–55	6,377,000
1956–60	5,260,000

Source: Computed from statistics of the British Columbia Department of Agriculture.

Table 12

Average annual soft-fruit production in British Columbia, 1959-62

Peaches	1,290,000 crates
Apricots	612,000 "
Pears	608,000 boxes
Prunes and plums	526,000 crates
Cherries	293,000 "

Source: B.C. Tree Fruits Ltd.

NOTE: The weights corresponding to the measurements used are as follows: box (pears), 42 pounds; crates (peaches, apricots and cherries), 20 pounds; and crates (prunes and plums), 15 pounds.

50 freeze, their production was drastically reduced to about 200,000 crates. Since that time, peach production has been averaging slightly more than a million crates a year. In 1959–62 the average annual peach yield was 1.3 million crates. Cherries and the prune-and-plum crop also reached a production peak before 1950, while pears reached their peak in 1957 and apricots in 1960. The annual production average of soft fruits for 1959–62 is shown in Table 12.

Because British Columbia's population is small, the economy of its orchard industry has depended primarily upon sales to the rest of Canada and exports to foreign countries. In 1900 the province began large-scale apple exports to the United Kingdom, and before World War I that country took 40 per cent of the yield. During the inter-war years British Columbia maintained the volume of its apple exports to Britain by providing a bright-red, carefully packed, high-quality dessert fruit. After World War II and the accompanying interruption of regular trade patterns, the United Kingdom market was again opened to large volumes of British Columbia apples. In 1946, when the province's exports to the British market totalled 2.5 million bushels, superior quality, packing and salesmanship gained for its apples the preference over those of Nova Scotia. For the next few years British currency problems made apple exports sporadic, and in some years no Canadian apples were accepted. Finally, in 1954, Britain established an allocation of apple imports from North America. Sixty per cent of the allocation was assigned to Canada, and British Columbia filled the largest part of it. In the four years between 1958 and the end of 1962, the province's apple shipments

to the United Kingdom averaged 700,000 bushels a year.

After World War II the United States became an important market for British Columbia apples, and in the late 1940's almost 2 million bushels went there annually. The decrease in apple production that came after 1950 reduced the quantities exported to the United States in the 1950's and early 1960's to an average of less than a million bushels a year.

At one time British Columbia had almost complete control of the apple market of western Canada. Since 1951 this control has been gradually declining and is now around 90 per cent in Alberta and Saskatchewan and 70 per cent in Manitoba. The shipments made to eastern Canada, which in 1946 totalled 1 million bushels, are now between 300,000 and 400,000 bushels.

In 1962, about 15 per cent of the province's apple yield was processed, 13 per cent was sold on the British Columbia fresh-fruit market, 34 per cent was shipped to other provinces, and the remaining 38 per cent was exported. The main processed product is apple juice and apples may in future have an important outlet in the manufacture of a sparkling cider recently introduced.

Only about half the soft-fruit yield is sold on the fresh-fruit market; the rest is processed. The province finds its market for fresh soft fruit primarily in western Canada, but even there its control is declining. Alberta and Saskatchewan, for example, received 100 per cent of their peaches from this source in 1948 and 1949 but only 36 per cent in 1956, and the proportion has since varied between 60 and 70 per cent. British Columbia's control of the Manitoba peach market, which stood at 100 per cent in 1948 and 1949, has in recent years fluctuated between 40 and 50 per cent. The big break in control of the Prairie market came after the drastic crop reduction that followed the freeze of 1949–50. By providing the Prairies with fruit for one year, Ontario and United States suppliers established a market for themselves for the years that followed (MacPhee, 1958, and unpublished data from B.C. Tree Fruits Ltd.).

A combination of factors has led to economic difficulties in the British Columbia orchard industry.

Right from the beginning the prices of orchard land in the Okanagan Valley were unrealistically high. They were further inflated when large numbers of Prairie farmers decided to spend their retirement years operating small orchards that they thought would provide them with a living and were willing to pay high prices for such holdings. As fruit-growing was highly profitable for a number of years in the 1940's, Okanagan orchardists were willing, on their part, to subdivide their property, believing that smaller holdings would bring them enough income.

A tourist boom encouraged by the warm sunny summers, beautiful bathing beaches and fishing in the upland lakes has also forced up Okanagan Valley land prices. As new motels, camping parks, entertainment facilities and cottages spring up all over the valley, lakefront lots of less than a fifth of an acre in such places as Penticton and Kelowna sell for from $3,000 to $5,000. This has caused an increase in the asking prices of adjacent orchard land.

The net result has been that orchard land prices in the Okanagan Valley range from $2,000 to $2,500 an acre, which is much too high in relation to present orchard profits. Although the price of fruit is about the same as it was in the 1930's fruit-growing costs have approximately tripled. The cost of an apple box, for instance, which was 14 cents in 1940, had risen by 1960 to 46 cents. With their margin reduced, growers have found it imperative to increase the size of their orchard holdings to make their industry economical, but many of them feel that it is uneconomical to increase such a holding at $2,000 an acre. Farm economists believe that $1,000 an acre reflects more closely the present economics of fruit-growing.

The average orchard in the Okanagan Valley, like the orchards of more than 70 per cent of the growers, is consequently smaller than 10 acres. It has been estimated that, because of the smallness of their holdings and the decline in profits, half the orchardists of the province cannot make a living from their fruit trees. The average grower can expect his orchard investment and labor to provide him with a house, a garden and enough cash to pay for depreciation on his equipment. To support his family he must augment his orchard income with off-farm earnings (MacPhee, 1958).

The large tree losses and drastic crop reduction following the freezes of 1949–50 and 1955–56, along with marketing problems resulting from United Kingdom restrictions on imports, led to a clamor from British Columbia orchardists for governmental assistance. After the freeze of 1949–50, the federal and provincial governments paid $250,000 to assist them in replacing dead

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trees. When, after the freeze of 1955–56, further assistance was demanded, a royal commission was appointed to investigate the province's tree-fruit industry (MacPhee, 1958).

In its report, instead of outright financial assistance the Royal Commission on the Tree-Fruit Industry of British Columbia recommended government-controlled long-term low-interest loans. It stipulated that such loans should be made only for orchards of more than 10 acres where site, soil and climate were favorable and only to farmers whose demonstrated managerial capacity was better than the average of their district.

The report also emphasized the need for detailed analyses of all the principal orchard districts to determine the suitability of their soil and climate for fruit-growing. The research station at Summerland and the Reclamation Committee of the British Columbia Department of Agriculture have made commendable efforts in this regard (British Columbia Department of Agriculture, 1952–54; Anstey, 1959). A Geographical Branch study includes a preliminary soil-climate tree-fruit classification for the Okanagan Valley and a recommendation that a more detailed study of orchard suitability be made on the basis of tree and crop failures and of above-average tree survival and yield as recorded on air photographs taken at five-year intervals to coincide with the quinquennial orchard survey (Krueger, 1963).

Among the many aspects of the orchard industry studied by MacPhee was the tree-fruit marketing procedure used in British Columbia. Lacking a sizable provincial market and facing stiff competition in the rest of Canada and in foreign countries, the industry learned early that survival required organized selling. The first co-operative central selling and distributing agency was formed in 1908, but its membership was not broad enough and many growers, instead of remaining loyal to the co-operative, negotiated private deals with shippers. So in 1913 the co-operative collapsed. The following year, however, with prices below the cost of production, the growers were impelled to organize another central selling agency. During the 1920's and early 1930's they were plagued with a series of legal battles over its legality, but finally, in 1934, the federal government's Natural Products Marketing Act legalized central selling.

Before 1938, the co-operative regulated only the flow of fruit to the market; the actual selling was done by individual packing houses. That year, B.C. Tree Fruits Ltd. became a one-desk selling agency and thereafter sold the fruit of all the orchard regions except the Vancouver Island-Lower Fraser Valley. The returns on individual fruit crops and the expenses they involve are pooled. Packing houses and growers are permitted to sell to retailers, roadside stands and consumers in their immediate vicinity. A consumer from outside the orchard regions may take home no more than 20 boxes of fruit a year. The selling regulations are strictly enforced (MacPhee, 1958).

The co-operative central selling agency has made it possible to maximize sales and growers' returns. The promotion of British Columbia apples is very effective throughout the United States as well as in the United Kingdom. Quality standards are strictly adhered to, and packing ensures that the quality is maintained until the fruit reaches the consumer. The flow to the provincial market is also controlled. Special quality and varieties are saved for foreign markets, where the competition is keenest. A co-operative processing plant helps to increase returns from substandard fruit and to reduce the surplus in bumper-crop years.

The survival of the British Columbia orchard industry in the face of many serious physical and economic problems has thus been due largely to an effective selling agency. The province should be able to continue the sale of its present volume of fruit production. In view, however, of present world supply and demand, substantial increases in orchard acreages do not seem to be desirable.

Certain aspects of the different orchard regions are now described in more detail.

REGIONS

Vancouver Island-Lower Fraser Valley

Although the region comprised of Victoria, in the southeast corner of Vancouver Island, and the Lower Fraser Valley from Hope to the mouth of the river provided sites for some of the first orchards in British Columbia, it never became important in tree-fruit production. The first growers were faced with problems that had not yet been solved. After waiting 10 years for an orchard to produce, they often found that the apples were of an unsalable variety. Because of the poor quality of their apples, their inability to control disease and insects, and the inadequacy

of grading and packaging, they could not compete successfully with United States suppliers even in the local markets. After years of unprofitable operation, these farmers began to neglect their orchards and turned to general farm crops and dairying. By 1900 it was obvious that Vancouver Island was not going to become an important orchard area. The Lower Fraser Valley continued to produce significant quantities of fruit until about the beginning of World War I.

Today a few scattered commercial orchards yield summer apples, cherries, pears, prunes and plums for the local markets. The growers are not members of the British Columbia Fruit Growers' Association and so do not come under the control of B.C. Tree Fruits Ltd. Because the region is not organized under the central selling agency, statistics on it are not given in the provincial surveys, but the 1961 *Census of Canada* indicates the region has 1,400 acres of orchard. From a study of air photographs and from field observations and interviews with officials of the provincial Department of Agriculture, the writer estimates that a total of 500 acres of commercial orchard is much closer to reality (Figure 7). The largest commercial acreage is in the Chilliwack census subdivision. There are several well-kept apple and pear orchards on the Saanich Peninsula of Vancouver Island, just north of Victoria.

Upper Fraser-Thompson

Some of the earlier commercial orchards were planted in the Upper Fraser Valley. By the beginning of World War I, orchards had been planted in the Fraser Valley as far north as Lillooet and in the Thompson Valley as far east as Chase. By 1920 there were 37,700 trees in the region. Their numbers declined in the following decade, but increased again from 1930 to 1950, when there were 72,900 fruit trees, including 59,600 apple trees, 5,400 prune, 2,835 pear and more than 1,000 each of cherry and peach. Peak apple production was reached in 1946, when the crop totalled 235,000 boxes. The winter of 1949–50 killed more than 50 per cent of the fruit trees in the region, with the result that in 1950–60 their numbers decreased by 53,000.

Today only the Kamloops district has sizable acreages of commercial orchard (309 acres in 1961). By the early 1940's, the failure of the private companies that supplied the district with irrigation water to keep the irrigation system in good repair and to set up a renewal fund, had caused such deterioration that there was a constant threat of water failure. In 1947 the B.C. Fruitlands Irrigation District was formed and in 1959 with both provincial and federal assistance, it completely rebuilt the irrigation system. In the last few years much of the irrigated land has been subdivided for houses, and it is expected that the expanding suburbs of North Kamloops will continue their advance into orchard lands.

Grand Forks—Kootenay—Arrow Lakes

In the early 1900's small orchards were planted over a wide area, from the Kettle Valley in the south to the shores of Upper Arrow Lake in the north. In 1914 there were more than 6,000 acres of orchard in the region. By 1960 this had shrunk to an insignificant 340 acres. A drive through the area shows orchard after orchard abandoned, some almost obscured by forest growth. The decline has been attributed to low-temperature injury, poor horticultural practices, disease, and neglect of orchards occasioned by the departure of young farmers for employment in mining, lumbering or construction.

The "little cherry" disease, which causes cherries to shrivel up so that they are unsalable, has been a major factor in the decline of tree-fruit production in the Kootenay Valley. It first started around Nelson in the 1930's and quickly spread throughout the Kootenay orchard districts as far as Creston. It is believed that the virus is spread by insects. Since sweet cherries were the best source of orchard income, their loss of importance was one of the main causes of orchard abandonment. In the whole region, only a few small orchards near Renata, on Lower Arrow Lake, have escaped the disease.

In 1960 the region's largest concentration of commercial orchard was in the Kettle Valley near Grand Forks. By the turn of the century orchards had been extensively planted there and around Rock Creek and Midway. This area, often called the "Boundary District", at first had no irrigation, but it was soon discovered that the annual precipitation of from 15 to 16 inches was insufficient for apple production. In the early 1900's, consequently, irrigation systems were established and orchard planting continued until 1920, when a peak of 107,000 trees was reached. The irrigation systems, however, had not been built to supply water in the quantities needed by mature orchards. Thus a lack of water, combined with severe winter kill and crop loss due to spring-

frost damage to blossoms, took such toll of the trees that by 1930 they had declined to 29,000. The decline was further hastened by the lack of orchard-management experience among the settlers, many of whom were former British Army personnel. Among the Doukhobors, the break down of communal activity in the early 1920's destroyed the ability to produce, process and market fruit crops co-operatively on a large scale.

The number of trees remained relatively constant during the 1930's and 1940's, but severe winters from 1949 on caused a further decline. Today a little more than 100 acres just east of Grand Forks is all the commercial orchard that remains. Most of the orchards are from 3 to 10 acres and provide a cash crop for general farm operations. Water from the old orchard irrigation systems is used for the cultivation of vegetables and small fruits. Potatoes have become an important district crop.

Creston

Creston is the most important British Columbia orchard region outside the Okanagan Valley. Most of the orchard land lies on a wide terrace around the town of Creston, high above the marshy flats of the Kootenay River. Fairly large commercial orchards are also found as far north as Wynndel and as far east as Canyon. A few small orchards are scattered farther north along the east shore of Kootenay Lake and as far south as Lister. There are no orchards on the river floodplain, which has been protected from flooding by dikes along the river channel, because the water table is too high and frost damage would be too great. Some orchards on the terrace slope extend right down to the floodplain, but the flats themselves are devoted to grain farming.

The principal tree fruit is apples (68 per cent) followed by cherries (21 per cent) and pears (6 per cent). A few peaches and prunes are grown for sale at roadside stands. McIntosh and Delicious, the most important apple varieties, make up 82 per cent of the apple crop.

The orchards in the Creston area are at a higher elevation than any other important orchard district in British Columbia. The winters are more severe than in any part of the Okanagan Valley south of Vernon. The record low temperature is −27°F. The temperature of −20°F (the critical temperature for dormant peach wood) has occurred in seven years out of 30. The 120-day frost-free period is much shorter even than that of the North Okanagan (Salmon Arm, 153 days). The late spring results in a late harvest season, which makes it possible for the Okanagan, with timely shipments to the Creston region, to capture the high prices prevailing there in the early season. The mean summer temperature (63°F) is not high enough for the best apple sizing and coloring. As the average annual precipitation is only 19 inches, irrigation of orchards is necessary. The heavy winter snowfall, on the other hand, helps protect the roots of the trees. Most of the region's orchard soils are silt and clay loams.

From 1920 to 1940, the number of trees in the Creston region remained around 100,000. By 1950 a peak of 130,000 was reached. Between 1950 and 1960, the total declined by 51,000. There are several reasons for the decline. For a number of consecutive years the weather was adverse, among its manifestations being winter and spring frosts that damaged trees and crops, hail that damaged almost ripened fruit, and cool, wet summers that made apples poor in size and color and caused an increase in scab infection. In recent years the "little cherry" disease has been decimating the cherry crop. Also, because tree-replacement programs have not been carried out, orchards are becoming overage and their yields are decreasing. The present apple yield per bearing tree is about 5 bushels; in the Okanagan Valley it is 8 bushels.

Many farmers have sold part of their orchards for orchard estates or as regular-sized house lots. Orchard holdings consequently average only a little more than 6 acres, which is much too small to provide a living for a family. Under these circumstances, fruit-growing has become only a part-time occupation and the effectiveness of orchard management has thus been reduced.

In view of both the physical and the economic problems, it would not be surprising if the Creston region continued to decline in importance as a tree-fruit area.

Okanagan Valley

On the basis of climatic differences and fruit types, the Okanagan Valley can be divided into two distinct regions. In the North Okanagan, where the winters are colder, the orchard area is devoted primarily to apples, and only one-quarter of it is used for soft fruits. In the South Okanagan, soft fruits occupy almost 50 per cent of the orchard area. As far north as Kelowna, orcharding and a little vegetable and small-fruit cultiva-

tion make up the only agricultural activity. Around Vernon there is a considerable amount of dry wheat farming. To facilitate more-detailed comparisons of the two regions, the whole valley is dealt with in one section.

In this paper the term "Okanagan Valley" refers to the entire depression that extends from the United States border to Salmon Arm, on Shuswap Lake, and includes the tributary Similkameen Valley, which joins the Okanagan (spelled Okanogan in the United States) south of the forty-ninth parallel.

The valley varies considerably in width, but is generally a little more than a mile wide in the south and broadens to about 8 miles in the north. In the south, it takes the form of a single trench. At Kelowna the main depression is divided by a great ridge in the centre. On both sides the valley walls rise steeply to the dissected plateau surface several thousand feet above the valley floor. Farther up the slope, the natural steppe vegetation grades into short grass and ponderosa pine. Finally, on the plateau, there is a humid coniferous forest.

As can be seen from Figure 7, the Okanagan orchards are not continuous along the valley. Some parts of the valley are enclosed by rocky walls that are either too steep or lack the required amount of soil. In other areas the soils are unsuitable for orcharding. Most of the orchards are planted on the water-worked till, outwash fans or lacustrine deposits that compose the broad terraces found in a number of valley areas. These terraces, with the exception of a few depressed areas that form frost pockets, afford excellent air drainage.

Although the soils that have supported the orchards of the Okanagan are of a wide variety, the best for all orchard purposes have proved to be the silt loams. The largest acreage of the very best soils for all crops is in the Summerland, Penticton and Naramata districts, around the southern end of Lake Okanagan. Both soils and climate are suitable for the production of all fruit crops on almost 8,000 acres of the valley lands. More than 5,000 of these acres have been irrigated, mostly in the South Okanagan.

Of the 32,500 acres planted to orchards, only 23,500 are suitable for tree-fruit production under the present economic conditions. Another 18,900 acres, however, are suitable for orcharding and would benefit by irrigation if water were available. About 2,500 acres of this available land are suitable for all tree fruits, and another 5,000 acres are suitable for all except the tender fruit crops made up of apricots, peaches and cherries. Thus it seems that there is room to transfer orchards from poor to more suitable land (Krueger, 1963).

A study conducted by a group of orchard specialists from the Summerland research station confirms that many fruit trees in the Okanagan are planted on inferior orchard sites. In 28 square miles of the Summerland district, the research team discovered that 29 per cent of the apricots, 17 per cent of the cherries and 9 per cent of the peaches were in unsuitable locations (Anstey et al., 1959).

The climate of the Okanagan Valley is hot and sunny in summer, cold and cloudy in winter. The South Okanagan has warmer summers, more moderate winters, and a longer frost-free period than the North Okanagan. The Penticton district has the mildest winters, the highest mean January temperature and the highest record low temperature. This is undoubtedly due to its being at the south end of Okanagan Lake. Summerland, has the highest frost-free period with 198 days. The surprising shortness of Penticton's frost-free period which lasts only 144 days, may be explained by the location of the meteorological station on flat, low-lying land 370 feet lower than the Summerland station that receives the cold air drained from the surrounding terraces. Horticultural specialists at the Summerland research station, agree that the frost-free season is as long on the Penticton terraces, where the orchards are situated, as it is at Summerland.

Statistics showing the frequency of temperatures critical for peach trees ($-12°F$ and $-20°F$) indicate that the area around the southern end of Lake Okanagan is the only one where the winter temperatures are as favorable for peach-growing as they are in the Niagara Fruit Belt (Krueger, 1963).

The survival rates for orchard trees in the Okanagan are very low. Only in the Penticton district do 50 per cent or more of the peach and apricot trees survive 10 years and 50 per cent or more of the apple trees survive 20 years. Since it is difficult to see how an orchard operation can be profitable if half the trees must be replaced before they reach peak production, these records seem to indicate that the growing of peaches and apricots is marginal outside the Summerland, Penticton and Naramata districts and that apple-growing is marginal north of Kelowna. The number of trees killed in the winter of 1949–50

supports the conclusion that the orchard climate around the southern end of Okanagan Lake is the best in the valley (Krueger, 1963).

Similarly, tree-yield records support the conclusion that the south-end-of-the-lake districts constitute the Okanagan Valley's best all-round orchard area. Penticton's yield, even for the hardy McIntosh apple, is the highest in British Columbia. In view of the unfavorable climate records, the Oliver-Osoyoos subregion has surprisingly high yields. Its output of peaches and Delicious and Winesap apples is the highest, on a per tree basis, and equals the Penticton yield of apricots. One explanation may be the subregion's hotter summers. Yield records seem to indicate, on the other hand, that the Keremeos-Cawston and Kelowna subregions are inferior for the production of apricots, peaches and cherries and that from Vernon to Salmon Arm apple growing is relatively unsuccessful. (For more detail on orchard suitability of the Okanagan, see Krueger, 1963.)

Orchard planting in the early years did not reflect the relative suitability of different parts of the valley. The first commercial plantings were made in the Kelowna and Vernon districts. In the early decades of this century, large numbers of apple trees and a few soft-fruit trees were planted in the North Okanagan from Peachland to Salmon Arm. There, the apple trees reached a peak of 785,000 in 1930, and from 1930 to 1950 large acreages of soft-fruit trees were planted. Since the freeze of 1949–50, the number of these apple trees has remained relatively constant while that of the soft-fruit trees has been declining. In the Salmon Arm subregion, the tree total declined between 1950 and 1960 by 75 per cent. In the same period the Vernon area's soft-fruit trees declined by 75 per cent and its apple trees by 30 per cent. The 145,000-tree increase that occurred in the Kelowna subregion in 1950–60 was composed primarily of apples.

In the South Okanagan the orchard industry developed much more slowly in the early years of the century. In 1920 the fruit trees were less than half as numerous as in the North Okanagan, and the Oliver-Osoyoos subregion had not yet been planted. By 1940 in the South Okanagan the number of trees had climbed to 680,000, or to about three-quarters as many as in the North Okanagan, and, for the first time, soft fruits were as important as apples. By 1950, the South had almost caught up to the North, and there were almost twice as many soft-fruit as apple trees. By 1960, the South Okanagan had more fruit trees than the North, although the latter still had a larger acreage because of the wider spacing of apple trees. In the 1950–60 period apple trees became slightly more important than in the previous decades reflecting the soft-fruit tree and crop losses due to the freezes of 1949–50 and 1955–56. Most orchardists, even in the best tender-fruit districts, like to have one block of apple orchard to ensure an income in case of failure of the other crops.

The climatic differences between the North and the South Okanagan are reflected in great differences in the importance of Okanagan apple varieties. In the Kelowna district, for example, the three Delicious varieties are 41 per cent of the total, while the McIntosh is 34 per cent and the Spartan 15 per cent. By contrast, in the Oliver-Osoyoos subregion the Delicious varieties make up 55 per cent, while Winesap makes up 32 per cent and McIntosh only 5 per cent. Not only are McIntosh trees hardier, but better quality McIntosh apples are produced in the areas with cooler summers. The Delicious trees are less hardy and require a great deal of summer heat to produce high-quality apples of good color. The Winesap tree is still less hardy but its fruit keeps well and is put on the market generally in late spring when other varieties are no longer available.

Precipitation varies from about 10 inches in the extreme south to 20 inches at Salmon Arm. The greater moisture of the North Okanagan slightly intensifies problems of disease control. The valley's maximum precipitation comes in the winter and results in a snow cover that protects the tree roots from frost. Unfortunately for cherry growers, precipitation reaches a secondary peak in late May or early June. In the South Okanagan the June rain is heaviest just before cherry harvest time, with the result that in some years the salable cherry crop is substantially reduced.

Because of the dry climate, orchard irrigation is necessary everywhere except the Salmon Arm subregion, and even there fruit production would be greatly increased if irrigation water were available. In several districts of the South Okanagan water is taken from an adjacent lake, but most of the irrigation water comes from the small upland lakes that occupy depressions on the surface of the surrounding plateau. By means of diversion and storage dams, the spring runoff is captured and controlled for use during the

summer. Water from the impounded lakes is fed down natural stream channels to points along the valley wall directly above the orchards. It is then diverted into flumes along the valley sides, whence it is distributed by control gates. The individual orchardist opens a valve near his control gate and diverts the water into his own orchard through smaller flumes. At one time the furrow system, which lets water run in little ditches between rows of trees, was the most popular, but in the last 20 years the sprinkler method has come into much greater use and is now used for about two thirds of the orchard area. Under this method, water is carried through portable aluminum tubing laid downslope between the rows of trees and then, under static pressure, is sprayed out of specially designed sprinkler heads. The sprinkler system operates with less water, causes less erosion, requires less labor, makes it easier to move machinery around the orchard, facilitates the establishment of a cover crop and the application of fertilizer, and has been proven to increase yields.

Irrigation in the Okanagan is a mixed blessing. It makes the yield much higher than in non-irrigated regions, but it also increases the cost of production. The cost of irrigation, including water charges, depreciation of equipment, and labor, ranges between $60 and $80 an acre.

Despite imposing physical and economic problems, the Okanagan Valley has become, and is likely to remain, an important orchard region. The reason lies in the excellence of the orchard management and the very high yields that have resulted, the high quality of the fruit, grading, packaging and the efficiency and initiative of the central selling agency. The economy of the valley orchard industry would be greatly enhanced if the orchards were reassembled into large holdings and if more care were taken to plant them only on sites where land type and climatic conditions were suited to the type of tree fruit.

CONCLUSION

Orcharding is a significant component of the agricultural industry in Nova Scotia, New Brunswick, Quebec, Ontario and British Columbia. In these provinces, because of the physical environment, the apple industry could be substantially expanded. The physical resources for soft fruits are much more limited. The most tender of the soft fruits—apricots, peaches and sweet cherries—can be produced successfully on a large scale only in British Columbia's South Okanagan and Ontario's Kent-Essex region and Niagara Fruit Belt.

All the orchard regions of Canada are confronted with the uncertainty of foreign markets, competition from imports, low prices and constantly rising production costs. The reduced margin per unit of production has tended to force small operators out of business while the large operators have increased both the size of their orchard holdings and the efficiency of their orchard management. In the many interviews he had all across the country, the writer discovered that farmers with fewer than 10 acres of orchard tended to complain about the lack of profit in the orchard business, while those whose holdings exceeded 10 acres were more content with the net returns from their operations. It is the writer's opinion that the large orchard operators are among the most progressive and prosperous of all the farm groups in Canada.

In view of the world apple-production picture, it is not likely that the volume of Canada's apple exports will expand substantially. For an increase in sales, the apple industry must therefore look to the domestic market.

Although Canada's annual average of fruit consumption has been constantly increasing since 1945, its per capita consumption of raw apples has shown a slight decline. With their raised standard of living, Canadians, instead of consuming more apples, tend to increase their consumption of citrus fruit and other imported out-of-season fruit. Through joint sponsorship of an adequate promotion program, growers and retailers should be able at least to maintain Canadian fresh-apple consumption at its current level.

Advertising concerning the quality and variety of apples should be increased. In taste and cooking suitability apples differ more from variety to variety than any other tree fruit. Despite this, a study of apple consumption reveals that the average housewife does not even know that there are different varieties (R. Choquette, 1959). An educational and promotion program should help dispel such consumer ignorance and thereby increase sales. The orchard industry itself should retain a certain quantity of such less popular but high-quality varieties as the Gravenstein, Golden Russet, Fameuse and Northern Spy. In this connection, it is interesting to note that many people closely associated with the apple industry consider the Delicious dessert apple inferior in

taste to a number of other Canadian varieties. Its large size and bright red color, however, have made it the most popular with the average consumer.

Canadian domestic consumption of fresh and processed apples combined is about three-quarters of a bushel per capita. Since Canada exports about 2 million bushels more a year than it imports, the average apple crop (16 to 17 million bushels) seems about adequate to the demand of the present population, which is close to 20 million. So long as the yield per tree continues to increase, it would appear unwise to make substantial new apple-tree plantings.

The marketing of soft fruits, which are perishable and must therefore reach the market within a day or two of being harvested, presents even more problems. If picked too green, the fruit does not develop its full flavor; if picked too ripe, it is very easily damaged in shipping. The bulk of fresh soft-fruit sales must consequently be made on the adjacent domestic market.

The Ontario soft-fruit producers can place tree-ripened fruit of high quality on the large adjacent urban markets at little cost in transportation. That they have not fully capitalized on this advantage is due to the lack of an efficient selling agency, the inadequacy of packaging and quality control, and competition from United States imports.

Because of their earlier growing season, United States fruit producers can place end-of-the-season surpluses on the Canadian market at low prices. Canadian growers, who consider this to be unfair competition, are partly protected by a higher harvest-season tariff. The tariff on imported peaches, for instance, is 10 per cent ordinarily but $1\frac{1}{2}$ cents a pound, or about triple the regular rate, during the 14-week Canadian peach-harvest season. The harvest-season tariff is approximately 12 cents on a 6-quart basket of peaches, which is hardly enough to discourage imports from growers who have already saturated their own domestic market.

Between 1951 and 1961, eastern Canada remained fairly steady in its purchases of fresh Ontario soft fruit but tripled its imports of fresh peaches and pears and more than doubled its imports of cherries. Recent legislation has tended to discourage United States distress selling of surplus fruit by basing import duties on a fair market value instead of on the value stated by the shipper.

A large part of Canada's soft-fruit production is processed. In canned fruits, Canadian growers also face stiff competition from the United States, where the cost of processing is lower. In 1961, for example, Canada imported about 30 million pounds of canned peaches (Ontario Department of Economics and Development, 1963). United States canned peaches, particularly the clingstone varieties, are generally more "rubbery" in texture and less "tasty" but are sold at lower prices, and it is the price tag along with aggressive promotion that usually determines the housewife's choice of tinned goods at the supermarket. Canadian fruit canners have done a poor job of promoting the higher quality of their product, and the task of winning it a good name is complicated by United States ownership of canneries in Canada. When the same trade name is used on both sides of the border, it is difficult to establish any identity for the Canadian product.

Canadian fruit growers and processors have been urging their federal government either to raise the import tariffs on fruit or to make a drastic change in the structure of protection against imports. They believe that a system of flexible quotas based on the total supply and consumption of each kind of fruit grown in Canada, with allowance for imports to make up the difference, would adequately protect both the growers and the processors.

It is the writer's opinion that the best hope for the solution of the orchard industry's marketing problems lies in more orderly marketing procedures and the close association of a central selling agency with the processing industry in each province. Thus far, this have been achieved only by British Columbia. The philosophy of orderly marketing and central selling was well stated by Arthur Garrish, president of the British Columbia Fruit Growers' Association, at the time of the royal-commission investigation of the British Columbia tree-fruit industry:

> "Without effective authority in the British Columbia Fruit Board over both provincial and interprovincial marketing of tree fruits, derived from Provincial and Federal Statutes, we believe that the orderly disposition of our product would cease, to be replaced by chaos, with indiscriminate price cutting as the main feature of the situation where everyone was seeking to dispose of his holdings and to avoid sharing in the risks and costs involved in the over-all programme.
>
> "While we agree that orderly marketing and central selling are not synonymous, we do contend that under our conditions, central selling and pooling of the proceeds have given orderly marketing and effectiveness of efficiency that could not otherwise be achieved.

"To those who say that this operation of ours is an attempt to abolish the law of supply and demand, we would point out that in not one single market do we enjoy a monopoly of supply. We must at all times compete with supplies from other producing areas on the continent, and in the case of American soft-fruit production, we must do so with an absolute minimum of tariff protection. A manufacturing industry can adjust to this law by curtailing production and by stock-piling against more favorable market conditions. We can do neither, and once the trees are planted and in production, Nature controls almost completely the volume in any one given season, and the perishable nature of the product demands that it must be marketed or dumped within a relatively short time.

"In these circumstances, orderly marketing is not designed to interfere with the law of supply and demand. It is rather an attempt to live with it from season to season on reasonable terms. . . .

"There may be those who, while agreeing with the advantages to be obtained from an orderly and planned disposal of the crop, will question the use of compulsion to obtain these ends. . . The industry has tried the alternative of voluntary co-operation and knows from bitter experience that it will not work. The whole history of our industry is filled with the struggle of our growers to bring about an orderly disposition of their produce on reasonable terms" (MacPhee, 1958, pages 45 and 46).

If the orchard industry of Canada would accept the principles of orderly marketing as just described, its number one marketing problem would be largely solved.

MS submitted January, 1964

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BOOK NOTES

SURVEYING INSTRUMENTS AND METHODS FOR SURVEYS OF LIMITED EXTENT. Philip Kissam, C. E., professor of civil engineering, *Princeton Univ.* Second ed. McGraw-Hill Book Company, Inc., New York, Toronto, London, 1956. Price $6.75.

A useful book for the physical geographer intending to make surveys of a small area. The section on optical tooling is suggestive of more refined techniques that would be useful for accurate repeated measurements of a small dynamic feature of the physical landscape.

Besides a well-condensed treatment of theory, which touches on the theory of errors, the book contains a wealth of practical advice that would take the beginner many years of field experience to acquire. Part II contains five-figure common logarithms, logarithmic and natural trigonometric functions, and a stadia reduction table, thus making the book a complete field companion.

There is also a bibliography of film strips and motion pictures on surveying and mapping techniques.

The treatment of instruments does not adequately reflect modern advances, and a person planning limited surveys would find an examination of modern optical theodolites and levels well worthwhile. The higher cost of reading instruments optically is quickly repaid by greater productivity from the field work.

(K.C.A.)

SURFICIAL GEOLOGY OF THE RED LAKE-LANSDOWNE HOUSE AREA, NORTHWESTERN ONTARIO. V. K. Prest, *Geol. Surv. Can.*, Paper 63–6, 1963. 21 p., plus 2 maps, tab.

This paper is particularly interesting in that it introduces a bedrock-drift distribution map to accompany the more orthodox map of surficial geology. Both are at the scale of 8 miles to the inch. Rock-drift distribution maps have been prepared by geographers, especially at McGill University and the University of Toronto, but few of them have been published and none have been published at so large a scale. There is no pretense at indicating depth of drift, and the text clearly points out the problems and limitations inherent in this kind of map. The classification, which shows where the rock outcrop is abundant, scattered, scarce or nonexistent, is intended mainly to show potential prospecting areas, but it serves also to complement the map of surficial geology.

The evidence of glaciation and deglaciation in this 47,000-square-mile area, which lies just north of the Great Lakes-Hudson Bay watershed, is depicted on the map of surficial geology and discussed in the text. The main contribution is the account of the sequence of events, among which are the formation of moraine systems and glacial lakes, ice retreats and re-advances, and marine invasion. On the basis of a few radiocarbon dates, these events are estimated to have occurred between 9,000 and 7,800 years ago.

A description of the glacial deposits, such as ice-flow features, moraines (including ground moraines), and glacio-fluvial and glacio-lacustrine deposits, follows the history of deglaciation. The paper concludes with a table of 26 mechanical analyses of tills below the 4-millimetre fraction.

(J.K.F.)

THE WESTERN INTERIOR OF CANADA, A RECORD OF GEOGRAPHICAL DISCOVERY, 1612–1917. John Warkentin, ed. Carleton Lib. no. 15. McClelland and Stewart Ltd., Toronto, 1964. 304 p., maps. Price $2.95.

This collection of source material concerns the exploration of the provinces of Manitoba, Saskatchewan and Alberta, a region for which the name *Western Interior of Canada* has been introduced. Excerpts have been selected from the journals, diaries and reports of explorers to illustrate how geographical knowledge of the region grew from the landing of Sir Thomas Button in 1612 on the coast of what is now Manitoba until 1917, when the last large uninvestigated area was described by a scientific observer. The excerpts describe physical features that persist today and stress the grassland and park country of the sedimentary plains. Dr. Warkentin has not only written an introduction but has linked passages throughout the text that provide biographical and historical background. The four maps show the main topographical features and the routes of the explorers.

(D.D.)

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